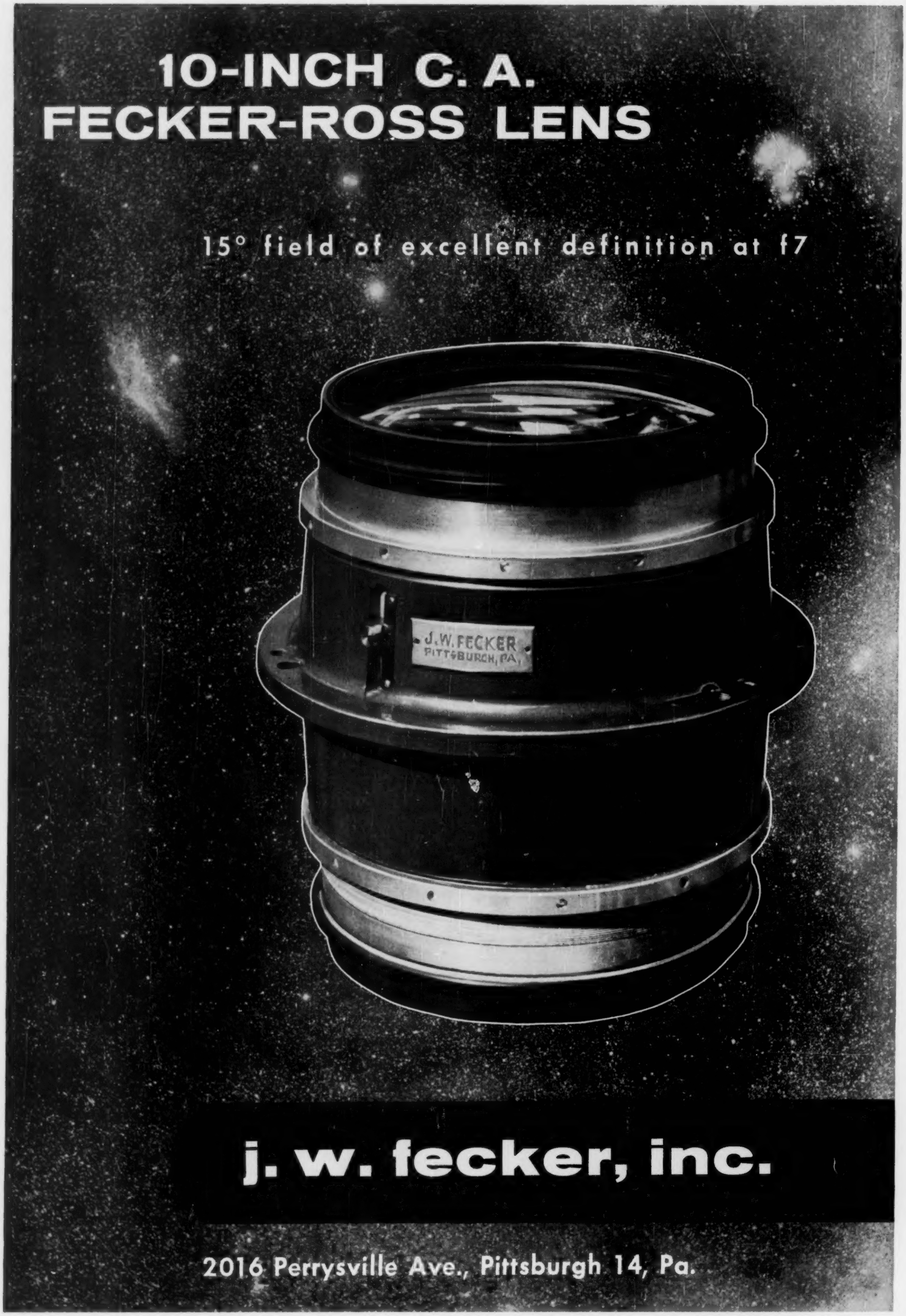
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Sky and TELESCOPE

CHARLES A. FEDERER, JR., *Editor*
HELEN S. FEDERER, *Managing Editor*
JOSEPH ASHBROOK, *Assistant Editor*

LETTERS

Sir:

I have many times observed Venus in bright daylight with the naked eye, and some of the aids that I use may interest other readers. It seems desirable to minimize the sky area to which the eye is exposed. To this end get into the shade, use one eye only, and sweep the desired area of the sky while looking through a short tube held in contact with the face. A cardboard mailing tube is fine, but simply cupping one's hands gives good results.

The relaxed eye will not always focus at infinity, and I have found it helpful to squint at intervals of about one second. After you have once found your target, the eye will remain in correct focus.

Without any ephemeris and depending only on the approximate relative positions of the sun and Venus on the evening before, I have found Venus many a time in bright daylight, flat on my back under a beach umbrella, using my hands in lieu of a tube.

M. S. GEREND
P. O. Box 844
Watsonville, Calif.

Sir:

After Venus had remained invisible to the naked eye by day for 128 days during its superior conjunction, I saw it on April 6, 1954, at 12:30 and 2:30 p.m. This was 223 days before the present inferior conjunction. At that time, Venus was an inconspicuous object east of the sun, appearing like a minute fragment of the daytime moon.

I adapted Dr. Miller's method for locating Venus by day, described on the Observer's Page of the August issue, to finding Jupiter on the morning of September 5th. The reference star, 29 Vulpeculae, was picked up the evening before in the finder of my 3-inch altazimuth refractor. Then a plumb bob was hung from the star diagonal of my instrument, using a cord long enough so the bob barely touched a nail stuck in the ground. The telescope tripod was not moved during the night. The predicted lag was 11 hours two minutes.

On looking into the finder at 8:43 a.m., Jupiter was easily seen, slightly north of where the star had been observed the night before. The 1.6-inch finder for this observation has a focal length of 10 inches, and was used with an Erfle eyepiece giving a field of five degrees.

HAROLD H. PETERSON
140 W. 22nd St.
Durango, Colo.

Sir:

Attention should be called to a valuable new Russian bibliography of current astronomical literature, whose title is *Referativnyi Zhurnal Akademii Nauk S.S.S.R. Astronomia i Geodesia*. The first four issues contain 1,950 abstracts, and cover astronomical papers, books, notes, and reviews published in the year 1953. In the preface, the editors state that the publication will appear monthly.

The quality of the abstracts appears to be quite good. Although the work is in Russian, the titles are also given in the original language, so that the publication has value even to those who do not read Russian. Sometimes illustrations, formulae, and tables are reproduced in the longer abstracts. One is impressed by the work that has gone into this undertaking. Many of the abstracts are signed by well-known astronomers; others are presumably by graduate students. Thus the Russians have provided their own substitute for the *Jahresbericht*, which has unfortunately not yet been brought up to date.

A. N. VYSSOTSKY
Leander McCormick Observatory
Charlottesville, Va.

Sir:

The September issue contains on page 400 a News Note describing diurnal temperature changes in the ozone region, as reported by A. U. Momin, of India, in *Current Science*. It is not made clear that his method is a modification of one which I have been using since 1941.

I pointed out in 1948 that if the sky radiation is measured near the horizon, as Momin has done, the deduced temperature of the ozone region is erroneous, because of atmospheric water vapor. Moreover, the 1948 experiments demonstrated the absence of any appreciable diurnal change in ERTOR, the effective radiation temperature of the ozone region.

The seasonal change in ERTOR, which Momin describes as possible, is actually a pronounced and well-known phenomenon. This is discussed in my paper in the *Bulletin* of the American Meteorological Society, *35*, 252, 1954, which also points out a hitherto unrecognized strong cyclical variation in ERTOR, with a period of 10 or 11 weeks.

ARTHUR ADEL
Atmospheric Research Observatory
Arizona State College
Flagstaff, Ariz.

VOL. XIV, No. 1 — NOVEMBER, 1954

CONTENTS

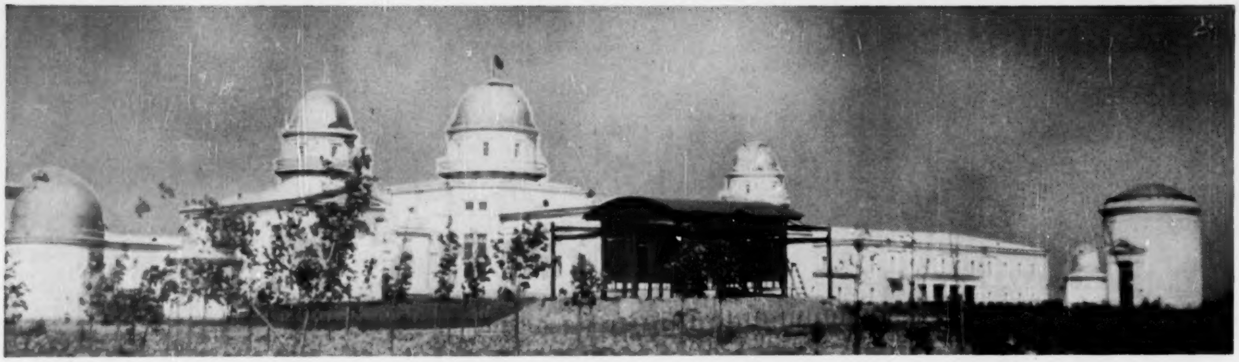
SKY AND TELESCOPE is published monthly by Sky Publishing Corporation, Harvard College Observatory, Cambridge 38, Mass. Entered as second class matter, April 28, 1939, at the Post Office, Boston, Mass., under Act of March 3, 1879; accepted for mailing at the special rate of postage provided in Paragraph 4, Section 538, Postal Laws and Regulations.

Subscriptions: $4.00 per year in the United States and possessions; $7.00 for two years; $10.00 for three years. Add $1.00 per year for Canada and for all other foreign countries, including Latin America, making the total subscription $5.00 per year, $9.00 for two years, and $13.00 for three years. Canadian and foreign remittances should be made in United States currency. Single copies, 40 cents, foreign 50 cents. Circulation manager, Nancy R. Bolton.

All notices of change of address must be sent one month in advance and accompanied by old and new addresses, or we cannot make the proper change. When sending your renewal order, or writing in regard to your subscription, your current mailing address must be given. For most efficient handling of your subscription, please return our bill form with your renewal payment.

Editorial and advertising offices: Harvard College Observatory, Cambridge 38, Mass. Unsolicited articles and pictures are welcome, bearing adequate return postage, but we cannot guarantee prompt editorial attention, nor are we responsible for the return of unsolicited material.

The principal articles in SKY AND TELESCOPE, beginning with Vol. XII, are indexed in THE READERS' GUIDE TO PERIODICAL LITERATURE.



The main building of the reconstructed Poulkovo Observatory. Several of the domes in the scene are on detached structures. All building scenes with this article are from 35-mm. Kodachromes by Dr. Nassau.

The Dedication of the New Poulkovo Observatory

BY DIRK BROUWER, *Yale University Observatory*
AND JASON J. NASSAU, *Warner and Swasey Observatory*

WITHIN A FEW YEARS of the opening in 1839 of the Poulkovo Observatory, which is on a hilltop 12 miles south of present-day Leningrad, it had achieved an outstanding place among the world's observatories. Until its destruction during World War II, the Poulkovo Observatory made valuable contributions to our knowledge of precise star positions, to double star astronomy, and to stellar spectroscopy. Thus the news that this institution has finally been restored is of interest to astronomers and other scientists throughout the world.

Between sessions at the Poulkovo Observatory are (left to right), front row, Brouwer and Jelstrup; middle row, Hoffmeister, Lindblad, and Danjon; and behind these, Cowling, Oosterhoff, and Sadler.

The formal opening of the rebuilt Poulkovo Observatory (see the front cover) was the occasion of the first important astronomical meeting with visitors from western countries held in the Soviet Union since before World War II. The letter of invitation had informed us that the ceremonies would begin in Leningrad on May 20th. On the evening preceding that date, the Soviet Aeroflot plane from Helsinki brought us to the Leningrad airport in the company of seven other western astronomers: W. S. McClenahan (Canada), A. Danjon and D. Chalonge (France), T. G. Cowling and D. H. Sadler (England), J. H. Oort (Netherlands), and B. Lindblad (Sweden).

At the airport we were met by two Poulkovo astronomers, A. A. Nemiro and M. S. Zverev, and representatives of the Academy of Sciences of the U.S.S.R. On a nearby ridge we could see the Poulkovo Observatory. It was obvious that it had been an inviting target for the German armies when they approached Leningrad in 1941.

We were taken to the Hotel Astoria, a prerevolution structure that still showed signs of former grandeur. The morning and afternoon of May 20th were spent sightseeing in Leningrad. During that day we also met astronomers who had arrived earlier or via Moscow. These were P. Bourgeois (Belgium), P. Tempesti (Italy), L. R. Terrazas (Mexico), H. S. Jelstrup (Norway), and M. Minnaert and P. Th. Oosterhoff (Netherlands). In the hotel were also housed scientists from Hungary, Czechoslovakia, Poland, Eastern Germany, the Baltic States, Bulgaria, Rumania, China, and North Korea. Not all of these were astronomers; some were mathematicians, physicists, or meteorologists.

Finally, there were among us about 10 interpreters who served us throughout our stay in the Soviet Union. They were indispensable at the ceremonies and scientific sessions. Our English-speaking group usually chose seats close together with English-speaking translators among us, who would furnish running translations of Russian speeches. This system functioned quite well but broke down occasionally when the tempo was too rapid or the speaker used too many technical terms.

Our interpreters would look after our interests in various other ways. They saw to it that we got transportation or tickets for shows, and our special requests always received considerate attention. Our especially assigned interpreter, for two Americans and one Canadian, was a man about 40 years old. He was employed by the Academy of Sciences to translate books from English into Russian. The translators were without exception well-educated men or women who were very conscientious and exhibited excellent teamwork.

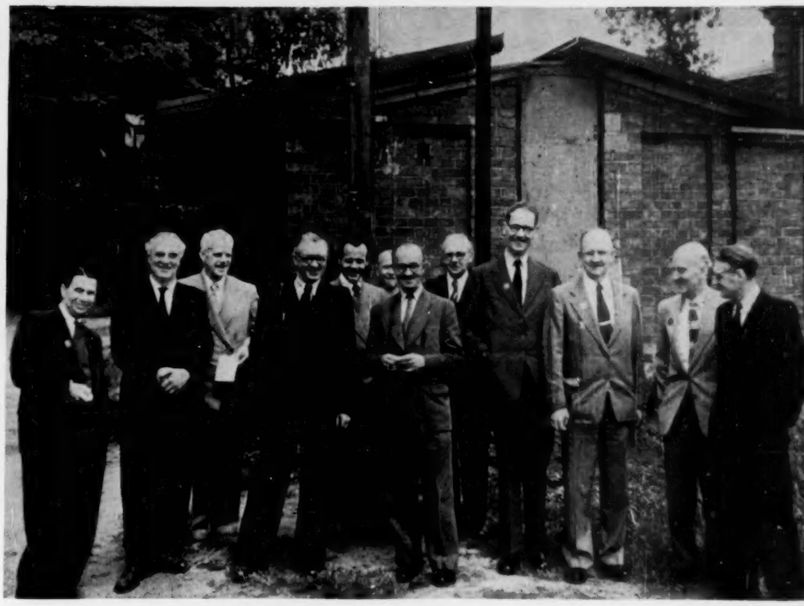
We were not in any way restricted to the company of our particular translator. Especially at meal time, the total group of about 50 seated at two long tables in the Astoria dining room would be thoroughly mixed, with only an indication of grouping according to language.

For the first event of the inauguration program, at 6 p.m. on Wednesday, May 20th, some 500 persons filled the very pleasant auditorium in the Academy of Sciences building in Leningrad. This ceremony and the events of the next two days were scheduled as a session of the division of physics and mathematics of the academy, and astronomers were only a minority in the

large company that gathered. During this occasion we had an opportunity to inspect Kepler's manuscripts, which had been previously housed at the observatory library.

The first event began with a brief speech by Prof. I. P. Bardin, speaking in place of Academy President A. N. Nesmejanov, who could not be present on account of illness. Then followed the principal address of the evening, by A. A. Mikhailov, director of the Poulkovo Observatory, on the history of that institution.

The next day we were taken to Poulkovo in automobiles. The first session was in the impressive auditorium of the observatory. There were some 30 speeches, by spokesmen for various scientific organizations of the Soviet Union and for foreign countries that were represented. General-Secretary Oosterhoff of the International Astronomical Union had the place of honor on the program, immediately following the opening remarks by the vice-president of the academy. The president of the union, Dr. Otto Struve, University of California, had also been invited to attend, but was unable to be present. His message in behalf of the union was presented by Dr. Oosterhoff and a translation was read in Russian.



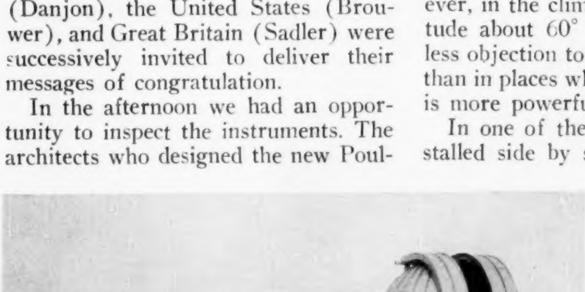
At the old Sternberg Institute in Moscow, these conferees informally gathered (left to right): Sadler, Bourgeois, McClenahan, Vorontsov-Velyaminov, Tempesti, (unidentified), Chalonge, Parenago, Cowling, Brouwer, Oort, and Kukarkin. Photograph by Dr. Nassau.

The Chinese mathematician Hua Loo-keng was the first foreign representative to take the speaker's stand. He spoke in Chinese, and was translated paragraph by paragraph into Russian by one of his countrymen. This enabled one of our translators to give us a running account in English. It was a very long, decidedly political speech. Later, spokesmen for France (Danjon), the United States (Brouwer), and Great Britain (Sadler) were successively invited to deliver their messages of congratulation.

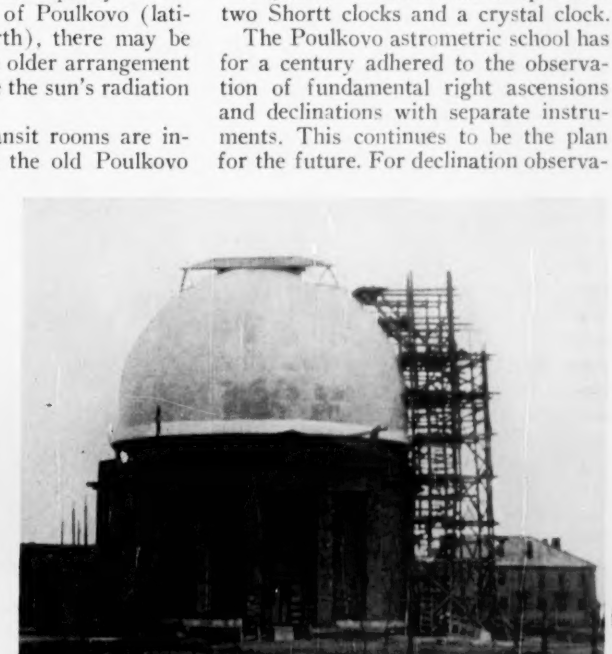
In the afternoon we had an opportunity to inspect the instruments. The architects who designed the new Poulkovo Observatory obviously aimed to make its general appearance correspond very nearly to that of the older structure, an exception being that the former octagonal domes have been replaced by hemispherical ones. The plan even includes the installation of meridian instruments in large rooms connected with the main building, as before. Modern practice prefers to locate such instruments in separate small buildings of low heat capacity. However, in the climate of Poulkovo (latitude about 60° north), there may be less objection to the older arrangement than in places where the sun's radiation is more powerful.

In one of the transit rooms are installed side by side the old Poulkovo transit by Ertel and Merz, to be used for the observation of the brighter stars, and an experimental horizontal transit instrument of the Atkinson design. In a corresponding room on the other side of the central hall are located an 8-inch Toepfer meridian circle, to be used for the observation of fainter stars in both co-ordinates, and a broken transit instrument for the time service. Housed in a separate room, the time service had in operation two Shortt clocks and a crystal clock.

The Poulkovo astrometric school has for a century adhered to the observation of fundamental right ascensions and declinations with separate instruments. This continues to be the plan for the future. For declination observa-



Above: The living quarters at Poulkovo are seen behind two telescope buildings. The staff numbers 200, of which 75 are scientists.



Right: The building of the new 26-inch refractor has a conventional round dome, rather than the octagonal type that covered the famous 30-inch Clark refractor.

The old quarters of the Sternberg State Astronomical Institute in Moscow. With a staff of 110, the institute is an important center for variable star research, and the time service of the Soviet Union is entrusted to it.

tions the Ertel vertical circle has been installed in a separate building.

Other older instruments that have been put into operation are the visual zenith telescope, first installed in 1904, and a Carte du Ciel astrograph, now used by A. N. Deutsch for proper-motion studies.

Among the new instruments is a beam-type interferometer with altazimuth mounting used for double star measurements. The new 20-inch Maksutov Schmidt-type instrument is provided with a spectrograph and means for spectrophotoelectric registration. Another new instrument is a fixed polar telescope designed by Mikhailov for the study of the motion of the north celestial pole among the stars. Instruments still to be installed include a large refractor to replace the 30-inch long-focus refractor that was once one of Poulkovo's most prized instruments. The lenses of this telescope were saved, but the mounting was completely destroyed. The new telescope is a 26-inch refractor with lens and mounting made in Germany.

For the present, the equipment is to a large extent limited to the older instruments upon which the excellent astrometric reputation of the observatory was based. As C. B. Watts and his associates at the U. S. Naval Observatory have demonstrated, the meridian circle can be made to be a more efficient instrument than it was 25 years ago and can yield more accurate results. If such improvements are introduced at Poulkovo, this observatory with its large staff of scientific workers should have an excellent opportunity to rank again among the leading astrometric observatories of the world.

The next day, Saturday, was taken up with papers by members of the staff on the history of the Poulkovo Observatory. Sunday was set aside for an excursion to Peterhof, the czars' summer palace near the Gulf of Finland. This was the first day of the season that the many fountains on the large estate were in operation. The occasion attracted huge but orderly crowds of people.

From Monday through Wednesday, two simultaneous conferences had been scheduled, one on astrometry, the other on variable stars. These conferences met on alternate days in Leningrad in the Maison des Savants, and at Poulkovo. The former is an old ducal palace now used as a club for members of the Academy of Sciences.

Most of the papers in both conferences were by Soviet astronomers, but some of the western astronomers had been given places on the program. Dr. Struve's prepared paper in Russian on Beta Canis Majoris contained introductory remarks about old personalities at Poulkovo; his humorous touch was much appreciated.

On the whole, the papers were in the nature of progress reports, and the time allotted to discussion was limited. However, in the astrometric conference there was much discussion concerning plans for a third observation of the Astronomische Gesellschaft stars in the northern hemisphere and the related meridian circle program. The conference at Evanston in 1953 had recommended a selection of meridian circle stars between visual magnitudes 6.5 and 8.5. At the request of the Evanston conference, F. P. Scott, of the U. S. Naval Observatory, had made a selection of stars that satisfied this requirement as nearly as possible. He had included all of Zverev's list of fundamental stars in the northern hemisphere and had made an effort to select as many stars as possible from Zverev's general list of faint stars without violating the magnitude requirement.

The conference on astrometry at Poulkovo expressed the opinion that the question of reference stars must be further discussed at a special international conference.

At Leningrad, we visited the Institute of Theoretical Astronomy where an elaborate set of punched-card machines was being operated, including four or five tabulators and five multipliers. The latter were not the most modern type now in use in the United States, and we did not see any electronic machines. We learned that the machines can do numerical integration of minor planets including Jupiter perturbations without approximation.

In Moscow, we visited the old Sternberg Institute as well as the new complex of buildings near Moscow University to which the Sternberg Institute will soon be moved. We were told that new instruments constructed in the U.S.S.R. were ready to be installed as soon as the domes had been completed. Among these instruments will be a broken transit, an 18-inch Maksutov telescope provided with objective prisms, and a 28-inch parabolic reflector now approaching completion. The Sternberg Institute is a training school for astronomers, but the instruction includes astronomical research. An institute of astrophysical research will be erected some 25 miles southwest of Moscow University.

We are indebted to the Soviet scientists for their hospitality, as well as to our National Academy of Sciences for making the necessary arrangements in securing passports and visas, and to the National Science Foundation for travel grants.

The nearly completed new home of the Sternberg Institute, showing to its left two of the domes for instruments. The skyscraper in the background houses part of Moscow University, which has an enrollment of 18,000 students. The institute is situated at the grounds of the university.

Early Daughters of Urania

By P. V. Rizzo
Amateur Astronomers Association, New York City

Caroline Herschel, as she appeared in a portrait by Tielemann in 1829.

MOST OF US are familiar with some of the contributions made to astronomy by Caroline Herschel, sister of the famous discoverer of Uranus. With her little telescope of 27 inches focal length and power of 20, she discovered clusters and nebulae, and found eight comets within 11 years. In addition, we may have heard how she assisted her brother in his tireless observations, acting as his indefatigable recorder, his assistant in the manufacture of telescopes, and his all-around helper at Slough Observatory.

Her published works include a catalogue of 561 stars from observations by Flamsteed. She also compiled a zone catalogue of all star clusters and nebulae observed by Sir William Herschel. For this latter work, she was awarded the gold medal of the Royal Astronomical Society in 1828, and in 1835 the society elected her an honorary member—a well-earned tribute. She died in 1848 in her 98th year.

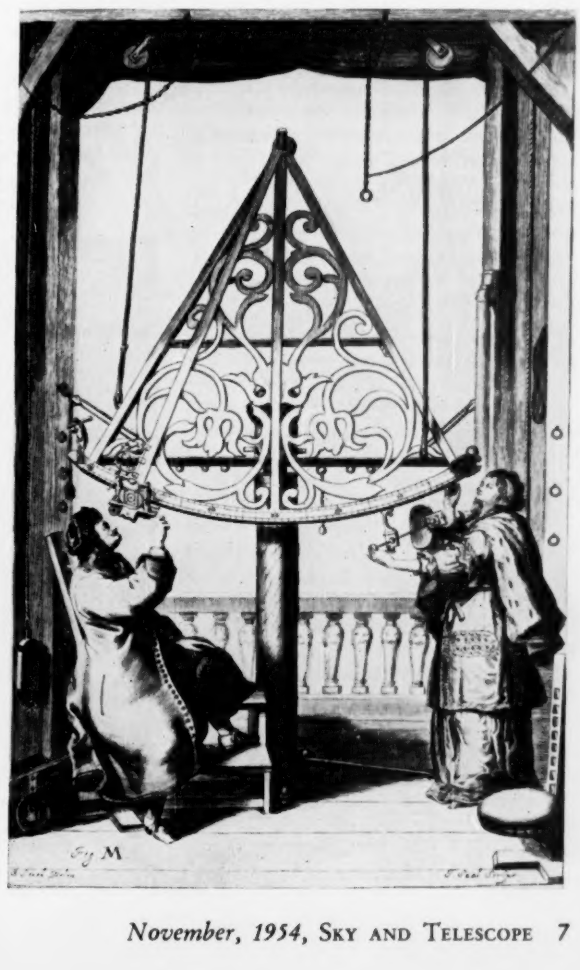
All in all, she was the first great star in the illustrious galaxy of lady astronomers. Any thorough history of the past hundred years in astronomy tells the names of others who followed her, names that have won the praise of the whole scientific world for work well done. The list grows annually as we read the achievements recorded in current publications from observatories throughout the world.

But — were there no renowned woman astronomers before Miss Herschel, or contemporary with her? Conventional histories say little, but there are hints here and there.

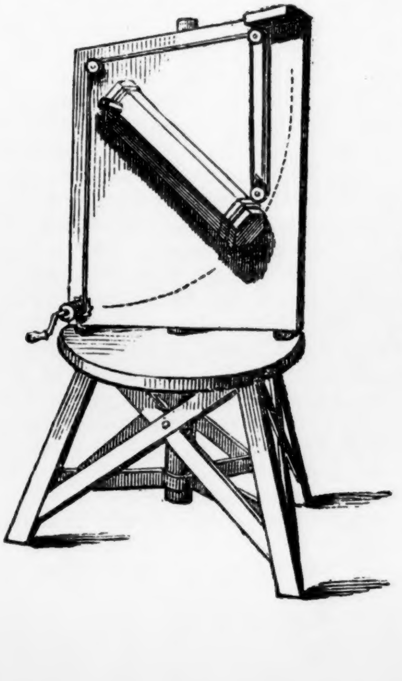
We notice for one thing that it was to the women especially that many early writers in astronomy addressed their remarks. When Fontenelle wrote his famous *Conversations on the Plurality of Worlds* in 1686, it was to a marchioness that he told his ideas about life on other planets. This custom spread even to America, where Professor Denison Olmsted, of Yale, published in 1840 his *Letters on Astronomy addressed to a Young Lady.*

These examples tend to show a special interest in astronomy by women prior to or contemporary with Caroline Herschel. And we find it was so; the names of many earlier ladies devoted to astronomy are enshrined in the pages of books like the 19th-century *Les Femmes dans la Science,* by A. Rebière (1897), or *Woman in Science,* published in 1913, by John A. Zahm, whose pen name was H. J. Mozans. Others are mentioned in various letters, personal recollections, and biographies.

It was in 1853 that the first important woman astronomer became a well-known figure, by the publication of Charles Kingsley's historical novel *Hypatia,* which was based on her life. Hypatia lived in Alexandria about 400 A. D., and was an outstanding scientific



Right: Elizabeth Hevelius and her husband observed with this large brass sextant made by Guenter in 1658. Hevelius used only naked-eye sights on his measuring instruments, even though he employed telescopes for lunar and other observations. From an engraving in Hevelius' "Machina Coelestis."



Left: Caroline Herschel used this small Newtonian reflector on an interesting altazimuth mounting for her comet sweeping. From a sketch in Admiral Smyth's "Cycle of Celestial Objects."

figure of her time. She was the daughter of Theon the younger, who wrote a learned commentary on the *Almagest* of Ptolemy. One book of this commentary was written by Hypatia. The medieval Greek encyclopediast Suidas mentions that she was the author of several works on astronomy and mathematics, which unfortunately are now lost. According to Bishop Synesius she invented an astrolabe and a planisphere. She gave lectures on science, art, and philosophy, and her admirers were many. But her extensive knowledge and charming beauty could not save her from a tragic end, for she was brutally murdered by a mob in the streets of Alexandria in 415 A. D.

There were no important woman astronomers for many years after Hypatia, until we encounter in the 15th century the shadowy figure of the wife and assistant of the Koenigsberg astronomer, Johann Mueller, better known as Regiomontanus. A little later, the Duchesse de Ferrare, Renée de France (1510-1575), is supposed to have had a keen interest in the astronomical theories of her day. In Denmark, Tycho Brahe's sister, Sophia Brahe (1556-1643), made astronomical observations, as appears in Gassendi's biography of him.

The never-published 17th-century manuscript of Jeanne Dumée exists today in the National Library in Paris. It discusses the arguments for and against the Copernican theory, and shows how observations of Venus and Jupiter offer proofs of its validity.

At about the same time, Maria Cunitz, born in 1610, the daughter of a doctor in Silesia, was pursuing her astronomical career. She had always been precocious, and at an early age she was familiar with seven languages. In 1630, she married a doctor who encouraged her astronomical inclinations. Her principal contribution was the improvement of tables of planetary motions.

Hevelius, the famous Polish astronomer of Danzig, was a wealthy amateur whose profession was engraving. Failing to find a reliable assistant, he turned to his second wife, Elizabeth Margarethe, who gave him much help in observing, as the engravings of her by Hevelius in his *Machina Coelestis* show. In 1652 they began observing for a catalogue of fixed stars. Unfortunately, a great part of their work was destroyed by fire in 1679. Hevelius died in 1687, and his widow carried on his work. She published his *Prodromus Astronomiae* and his *Firmamentum Sobiescianum*. The latter book she dedicated to the king of Poland, John Sobieski, and in it she named in his honor the constellation Scutum Sobiescianum, today called Scutum. Their catalogue contained 1,564 stars, and was both

Mme. de la Sablière (1636-1694) was an enthusiastic amateur astronomer.

the largest and the last made without the help of a telescope.

Another friend of Sobieski's, Mme. de la Sablière, gained notoriety as a lover of astronomy. So enthusiastic was she that the French poet Boileau wrote a satire against her. He complained that she had ruined both her sight and her complexion by continually running about following Jupiter with an astrolabe in her hand.

Nearly contemporary was Maria Clara Eimmart, born in 1676 at Nuremberg, daughter of the engraver and amateur astronomer, Georg Eimmart. With her father's help, she made valuable drawings of comets, sunspots, and lunar mountains. She died in 1707.

Mme. Lepaute (1723-1788) was famous as a calculator of comet orbits and of eclipses.

Discoverer of the comet of 1702, Maria Margarethe Kirch is next on our list. Born in Saxony in 1670, the daughter of a minister, she married Gottfried Kirch, and assisted him in observing and in the calculations for his almanacs. When he died, she continued to publish the almanacs with the help of her son, Christfried, who became director of the observatory in Berlin. His sister, Christine Kirch, was his assistant.

The famous Mme. Hortense Lepaute, born on January 5, 1723, gained prominence when Clairaut and Lalande sought to predict the time of return of Halley's comet. Remembering her part in this work, Lalande later wrote, "During six months we calculated from morning to night, sometimes even at meals; the consequence of which was that I contracted an illness which has changed my constitution for the remainder of my life. The assistance rendered by Mme. Lepaute was such that without her I should never have been able to undertake the enormous labor, in which it was necessary to calculate the distance of each of the two planets Jupiter and Saturn from the comet, separately for each successive degree for 150 years."

The comet was first seen by Palitzsch, a German amateur, on December 25, 1758. It reached perihelion on March 12, 1759, which was within the limits set by the calculators.

Mme. Lepaute assisted Lalande in many other mathematical labors, from which she became nearly blind. Her computations for the eclipse of 1764 were used throughout Europe.

The wife of Lalande's nephew was Mme. Marie Jeanne de Lalande, who made extensive reductions of observations for her husband's star catalogue. A daughter was born in 1790. A comet discovered by Caroline Herschel was first seen in France on the day of her birth, and the infant was named Caroline in honor of the discoverer.

In an article on the history of astronomy for 1802, published in the *Philosophical Magazine*, Jerome Lalande wrote, "C. Lalande, my nephew, continues to observe the right ascensions and declinations of a great number of stars not well known; and Mme. Lalande continues the reductions, which she promised, for the 50,000 stars."

Minna Witte, who was born in Hanover in 1777, was an active observer, and constructed a large globe of the moon that attracted much praise. The story is told that the famous selenographer, Maedler, tried vainly to purchase this globe, and finally married the lady to secure it as a dowry.

The place of Mary Somerville in the history of astronomy is an important one. She was born in Scotland on the

Mary Somerville, Laplace once said, was the only woman ever to have mastered his "Mécanique Céleste." Her picture is from a portrait by Surinton.

26th of December, 1780. Through self-education she mastered the most difficult mathematical works of her time, including Laplace's *Mécanique Céleste*. Her writings on celestial mechanics were widely studied. In 1831, she published for the general reader her *Mechanism of the Heavens*, which was immediately popular. In 1834 appeared the *Connection of the Physical Sciences*. The following year, at the same time as Caroline Herschel, she was made an honorary member of the Royal Astronomical Society. Many incidents of her long life devoted to science are told with much humor in her *Personal Recollections of Mary Somerville* (1873).

Shortly before the death of Miss Herschel, America's first famous woman astronomer became a well-known figure. On the night of October 1, 1847, Maria Mitchell discovered a telescopic comet, for which she was awarded the medal offered by the king of Denmark for such discoveries. Although this was the beginning of her international reputation, Miss Mitchell had been studying the sky long before that. When she was only 12 years old, she acted as timekeeper for her father in observing the annular eclipse of 1831.

The cold winters of her native Nantucket Island, off the Massachusetts coast, did not keep her from spending hours at the telescope enthusiastically sweeping the heavens. Later she became professor of astronomy at Vassar College. Her activity there was the direct inspiration of an accelerated interest in astronomy not limited to women alone. Many honors were conferred on her by universities and learned societies. Besides her scientific work, she participated in movements

This daguerreotype of Maria Mitchell was made when she was about 30 years old. Photograph, courtesy Margaret Harwood, Maria Mitchell Observatory.

for the advancement of women. Details of her life are to be found in Helen Wright's *Sweeper in the Sky* (1949) and in the earlier *Maria Mitchell*, compiled by Phebe Mitchell Kendall (1896), a sister of Maria. We can consider Miss Mitchell's election to the Hall of Fame in New York City as a symbol there of all the other women astronomers who came before and after her.

✶ ✶ *SKY AND TEACHER* ✶ ✶

Sponsored by the

Teachers' Committee of the American Astronomical Society

Books for Amateurs—continued

THE AMATEUR astronomer who wants up-to-date and reliable information often feels the need for a list of suitable books that are not too technical. Such a list can also be a convenience to societies and to teachers who receive requests for recommended reading. This month, titles are given for some books covering either the whole field of astronomy or major areas of it, that are suitable for intermediate and advanced amateurs. The prices quoted are subject to change.

In September were listed books for children and for beginners; it is planned to deal later with books on special branches of astronomy and on observing.

TEXTBOOKS

There are a number of good textbooks used in elementary college courses, suitable for reading at the intermediate level, including those listed below. These same authors have in some cases prepared shorter volumes under different titles (designed for use in one-semester courses).

Astronomy, Robert H. Baker. D. Van Nostrand Co., New York, 5th edition, 1950, $5.00.

Astronomy, John C. Duncan. Harper and Bros., New York, 5th edition, 1954, probable price, $5.50.

The Astronomical Universe, Wasley S. Krogdahl. The Macmillan Co., New York, 1952, $6.25.

Astronomy, William T. Skilling and Robert S. Richardson. Henry Holt and Co., New York, revised edition, 1947, $6.50.

Introduction to Astronomy, Cecilia Payne-Gaposchkin. Prentice-Hall, Inc., New York, 1954, $8.00.

Some Famous Stars, W. M. Smart. Longmans, Green and Co., New York, 1950, $2.50. A popular discussion of astrophysics based on the study of seven of the stars from which we have learned the most.

Basic Astronomy, Peter van de Kamp. Random House, New York, 1952, $3.75. This nonmathematical survey is noteworthy for a clear account of the distances and motions of the stars.

SUPPLEMENTARY READING

The History of Astronomy, Giorgio Abetti. Henry Schuman, Inc., New York, 1952, $6.00. A readable account of the development of astronomy places its history in good perspective.

From Atoms to Stars, Martin Davidson. The Macmillan Co., New York, 3rd edition, 1952, $3.75. Provides good supplemental reading about the nature of the sun and stars.

The Growth of Physical Science, Sir James Jeans. Cambridge University Press, New York, 2nd edition, 1951, $3.75. A description of the findings that have contributed to today's knowledge in all the physical sciences, and some account of the men and women who played a part.

Measuring Our Universe, Oliver Justin Lee. Ronald Press Co., New York, 1950, $3.25. Discusses in leisurely fashion the fundamental importance of accurate measurements.

THE HARVARD BOOKS ON ASTRONOMY

This series, written by staff members of Harvard College Observatory, can be especially recommended. The books are now published by the Harvard University Press, Cambridge 38, Mass.; the three volumes for which prices are not given are temporarily out of print.

(Continued on page 23)

The Interaction Between Stars and Nebulae

By Otto Struve, *Leuschner Observatory, University of California*

If the stars have been formed —or perhaps are even now being formed—out of interstellar gas and dust, we might expect that the interstellar clouds are more tenuous than they were, say, five billion years ago. But it is also possible that the stars, in the course of their evolution, may shed matter that ultimately augments the depleted nebulosities.

These ideas are not new. The Russian astronomer B. A. Vorontsov-Velyaminov has for many years favored the hypothesis that the stars actually shed more gas than they acquire, so that all presently visible nebulosities have once been inside the stars. Other astronomers, for example L. Biermann in Germany, have examined the possibility of an equilibrium state, in which the mass acquired by the stars from the diffuse medium is about equal to the mass they expel in the form of novalike explosions, rotational breakup, or corpuscular radiation.

Still others, especially G. A. Shajn and V. Hase, in Russia, have suggested that while exchange of material between stars and nebulae goes on all the time, this process is a very minor one. They propose that both stars and nebulae originated at about the same time, in some unspecified primordial medium whose properties may have been those of what the western astronomers describe as the prestellar state of matter, or what G. Gamow calls "ylem."

It would be important to know whether the interstellar gas and dust that we now observe is the remnant of the original medium, retaining its original chemical composition, or is of the substance of stars, modified in its hydrogen-to-helium ratio, and perhaps also in the abundances of the heavier elements, by the nuclear processes in stellar interiors.

FACING PICTURE: A portion of the Rosette nebula in Monoceros, photographed with the 48-inch Palomar telescope. Against the background of bright nebulosity are black wisps and tatters of dust clouds and, in particular near the center of the picture, minute dark round blots. These are globules—dust clouds only a few thousand astronomical units in diameter, that may be contracting to form stars. Toward the upper right is part of the star cluster NGC 2244. South is above, east to the right; the scale is about nine seconds of arc per millimeter. Mount Wilson and Palomar Observatories photograph.

The California nebula in Perseus has a delicate filamentary structure when photographed in the red light of hydrogen. The nebula is much fainter in ultraviolet light, and is practically invisible in yellow light. Harvard Observatory photograph.

Several observational results seem to indicate that very old stars are poorer in heavy elements than recently formed stars. Thus, in July, B. Stroemgren gave in his Liége report the following summary of the content of metals: in very young stars, 3%; in medium-age stars, 2%; in fairly old stars, 1%; and in extremely old stars, 0.1%.

The foregoing suggests that the interstellar medium out of which the stars in Orion, for example, are being formed at the present time is considerably richer in heavy elements than the original gas, five billion years ago, out of which the stars in globular clusters or in the central bulge of the Milky Way were formed.

Further insight into these problems is offered by our present knowledge of how the stars transfer mass to the interstellar medium. We shall follow a compilation by Biermann presented at the Cambridge symposium on gas dynamics of interstellar clouds, in July, 1953. However, his results differ only slightly from those presented in 1948 by Vorontsov-Velyaminov in his book, *Gaseous Nebulae and Novae* (now available in a German translation).

The interactions which lead to the loss of mass are:

I. Catastrophic explosions: *a*, in supernovae and novae; *b*, in planetary nebulae; *c*, in P Cygni-type stars of various kinds.

II. Slow, continuous corpuscular emission: *a*, in Wolf-Rayet stars; *b*, in supergiant stars; *c*, in main-sequence stars of about the type of the sun; *d*, by single early-type stars; *e*, by rotational breakup in single stars and close binaries.

If the matter in the universe is in equilibrium—in the sense that the masses of the stars and of interstellar matter combined remain constant, without of necessity being equal to each other — then the loss of mass from processes I and II must be balanced by the following reverse reactions:

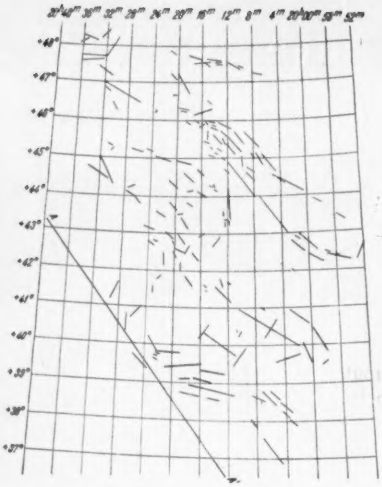
III. Continuous accretion of interstellar matter: *a*, by stars of large mass in average interstellar clouds ("rejuvenation"); *b*, by ordinary main-sequence stars in very dense dust clouds (for example, T Tauri-type stars).

IV. Formation of stars in very cold and dense regions of interstellar material.

Biermann remarks that processes II and III cannot be expected to occur simultaneously in any particular star. It can be shown that if conditions favor expulsion of atoms from stars, this process will be a very stable one; small changes in temperature or other physical conditions will not reverse it.

We shall now proceed to estimate the effectiveness of processes I and II. No one really knows how much mass is converted into nebulosity during a supernova explosion. A rough guess is about two solar masses. (To facilitate notation, in the following discussion numbers otherwise unlabeled refer to the mass of the sun as a unit.) If there is, on the average, one supernova in 200 years in our galaxy, the interstellar matter would gain at the rate of 0.01 (solar mass) per year. The ordinary novae lose much less matter per explosion, say about 10^{-5}, but about 100 novae occur in the galaxy each year. Thus they contribute 0.001 per year.

For the planetary nebulae, K. Wurm estimated a loss of 3×10^{-5} per year. There are about 500 planetaries in the Milky Way at the present time—and thus presumably at any time — even though in any particular star the planetary-nebula stage may last only a few thousand years. Hence, all planetary



Left: A composite photograph of nebulosity in the region of Gamma Cygni, made at the Crimean Astrophysical Observatory. Above: A map of the same region, reduced 17 to 10 in scale, on which Shajn and Hase have drawn the directions of filaments in the photograph. The slanting line AA′ is the galactic equator.

nebulae send out interstellar gas amounting to 0.015 per year.

For the P Cygni-type stars, Biermann gives no estimate, but says, "It seems unlikely that these stars contribute more than the planetary nebulae." I believe a reasonable estimate is again 0.015 per year.

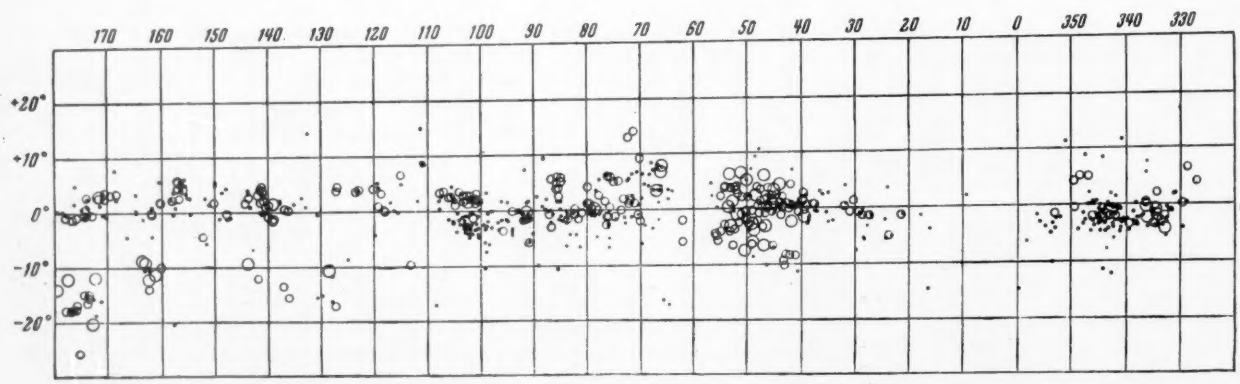
In the spectra of the Wolf-Rayet stars, we observe strong and exceedingly broad emission lines which, according to C. S. Beals and many later investigators, are produced in semipermanent expanding shells. These stars are about six times as large as the sun, and their luminosities are roughly 20,000 times greater. Their masses are about 10 times the solar mass. From the intensities of the emission lines, Biermann adopts a loss of mass of 10^{20} atoms per square centimeter per second. The surface area is 2×10^{24} square centimeters, and one year contains about 3×10^{7} seconds; hence, each Wolf-Rayet star loses about 5×10^{-6} solar masses per year. Biermann estimates that there are between 1,000 and 10,000 such stars in the Milky Way at any one time. Their total annual contribution to the interstellar gas is thus of the order of 0.01.

Vorontsov-Velyaminov makes this estimate 10 times larger: 0.1 per year, or 5×10^{8} solar mass units in five billion years, and he suggests that the entire present diffuse constituent of the Milky Way can be accounted for by the expansion of the Wolf-Rayet stars. But it seems to me that this is based upon an underestimate of the present mass of the interstellar material. If it is equal to that contained in the stars, or 10^{11}, then only 1/200 of the interstellar gas was once inside the stars, if we adopt the Vorontsov-Velyaminov figure for the rate of ejection.

The ordinary supergiants do not change the picture appreciably. Although Biermann uses a value of 0.0001 for the annual loss of mass, this is clearly an overestimate, and he assumes that there are 50,000 such stars in existence. It seems better to adopt 0.01 for their total annual contribution.

The sun loses atoms in the form of clouds of protons and other ions, whose effects we can observe in comet tails, magnetic storms, northern lights, and even in some relatively low-energy cosmic rays. Biermann had previously estimated the intensity of the sun's corpuscular outflow from geomagnetic, cometary, coronal, and zodiacal light observations. The result was 10^{-12} solar masses per year. But undoubtedly many stars, such as those with flares, are much more powerful emitters of particles. Hence we shall use 10^{-11} for each star. Since there are about 10^{11} such stars in the Milky Way, we find here a really powerful source of interstellar gas, about one solar mass annually.

A star of early spectral type undoubtedly emits particles much more copiously than the sun. The work of V. G. Fessenkov and A. G. Massevich has indicated that the rate of loss of mass is proportional to the luminosity of a star. A *B*0 star is about 5,000 times more luminous than the sun, but there is perhaps only one such star in our galaxy for every 5,000 stars like the sun. Even so, the *B* stars should contribute at least as much as all the solar-type stars.



To test the relationship between galactic nebulae and early-type stars, Shajn and Hase have plotted their positions on this chart of the northern Milky Way. The horizontal and vertical scales are galactic longitude and latitude. Diffuse nebulae are denoted by circles, and the dots are for stars of spectral types O, B0, and B1, as well as for Wolf-Rayet stars. The early-type stars and the diffuse nebulae both show a noticeable tendency to clumping, but there appear to be numbers of nebulae, especially in the lower left part of the chart, that have no evident connection with stars of these varieties.

Biermann declines to estimate the loss of mass from rotational or orbital instability. The shell of a rapidly rotating star is tenuous, and I once estimated that its mass might amount to 10^{-8} at any given moment. Few shells show large motions of expansion, but a replenishment of the entire shell (or ring) in about a year is a reasonable guess. Each of the most rapidly rotating stars would then contribute 10^{-8} per year. But their number is relatively small, and their total contribution probably does not exceed 0.01 per year.

The close double stars, especially of the Beta Lyrae and Algol types, may lose mass more rapidly, perhaps at the rate of 10^{-4} or 10^{-5} per year. But they are not sufficiently numerous in the galaxy to upset our rather shaky apple cart of estimates. Let us allow for them a contribution of the order of 0.1 per year.

ANNUAL LOSS OF MATTER TO THE INTERSTELLAR MEDIUM

Type of object	*Solar mass*
Supernovae	0.01
Novae	0.001
Planetary nebulae	0.015
P Cygni stars	0.015
Wolf-Rayet stars	0.01
Supergiants	0.01
Main-sequence stars (solar type)	1
Main-sequence stars (*O* and *B*)	1
Shell stars	0.01
Close binaries	0.1
Sum	2.2

Our foregoing estimates are listed here. All the values are rough, but we have been quite conservative, on the whole, in our computations, and we can infer that the annual gain of interstellar matter may be between one and 10 solar masses. Hence, in the lifetime of the galaxy, say 5×10^9 years, the total amount of gas expelled by the stars may have amounted to as much as 5×10^{10}, or 50,000 million times as much matter as in the sun.

This would be a considerable fraction of the present amount of diffuse interstellar material, and might justify the belief that some, but probably not all of this matter had at one time or another been inside stars. It also makes more plausible the idea that the stars and the interstellar matter are in equilibrium with each other, for it is not unreasonable to suppose that on the average between one and 10 fresh (or rejuvenated) stars are produced annually in the Milky Way.

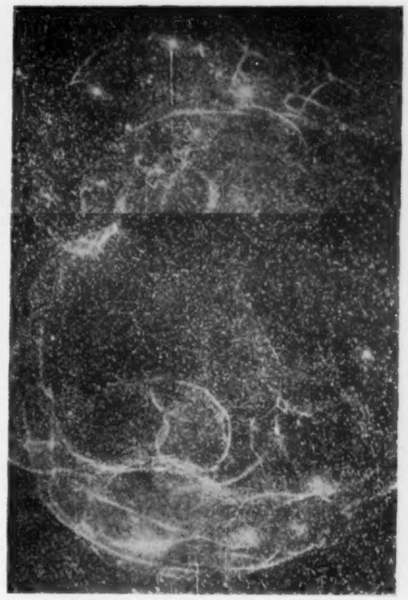
Let us consider, for example, a typical "young" association of stars. It may contain some 100 stars, none older than about one million years. Hence, within a single association one fresh star appears at an average rate of once in 10,000 years. V. A. Ambarzumian has estimated that the number of T Tauri associations in the Milky Way may be over 10,000. The associations of *O* and *B* stars are less frequent, but the galaxy may contain as many as 1,000 of them. Thus, it is possible that the present star birth rate may lie between one and 10 each year, and this would serve to balance the loss of mass.

It would, however, be wrong to infer that all or most of the gaseous nebulosities are recent products of stellar expansion. This has become especially clear from the work of Shajn and Hase. We summarize and comment on their conclusions in the remainder of this article.

1. Several diffuse nebulosities have masses of the order of 1,000 or 5,000 suns. Yet, these nebulosities contain only relatively few stars, between 10 and 100, and such large nebular masses could not possibly have been expelled from the stars now associated with them. In addition to the one in Orion, these giant nebulae include the Lagoon nebula in Sagittarius (M8) with a mass of 3,200, and the Rosette nebula in Monoceros (NGC 2237) with a mass of 5,800. For the last, in 1949 R. Minkowski even gave a mass of as much as 10,000 suns. His photograph of this object (on page 10) reveals many typical globules, those tiny dark nebulae that B. J. Bok regards as stars in the making. They are so numerous that I feel we are justified in believing that here, at any rate, the process of new-star formation greatly exceeds that of loss of mass by the existing stars.

2. If we plot, with Shajn and Hase, the galactic co-ordinates of the Wolf-Rayet, *O*, *B*0, and *B*1 stars, and of the nebulosities, we find that there are many early-type stars without nebulae, and many nebulosities without early-type exciting stars. It is true that, according to Hugh Johnson's recent work at the Yerkes Observatory, probably every *O* star has a luminous H-II sphere of nebulosity around it. But it is also certain that two spectroscopically indistinguishable *O* stars may be associated, the one with a very bright nebula, the other with a nebula of exceedingly low surface brightness.

3. The emission-line stars of spectral classes *O* and early *B* certainly rotate very rapidly, and many of them are near the point of equatorial instability. They might be expected to shed gas more rapidly than the ordinary absorption-line *O* and *B* stars. Yet Shajn and Hase find that the emission-line stars are less apt to be associated with gaseous nebulae.



This complex of peculiar filamentary nebulosity appears to be associated with Nova Aurigae 1891, and was recently photographed at the Simeis Observatory in the Crimea. The nova is situated at right ascension $5^h\ 28^m.8$, declination $+30°\ 25'$ (1950), and reached the 4th magnitude at its maximum brilliance. The heavy concentration of nebulous filaments near the bottom of the field is located nearly four degrees from the nova's position. Shajn and Hase consider it possible, but improbable, that the light of the nova excites the nebulosity to shine.

4. There is no greater tendency among the Wolf-Rayet stars to be associated with nebulosities than among *O* and *B* stars. Yet, the individual Wolf-Rayet stars are the more copious suppliers of interstellar gas.

5. In some of the widely dispersed fields of nebulosity, especially in the region of Alpha and Gamma Cygni, the filaments of nebulous matter show a tendency to be oriented parallel to the plane of the Milky Way. It may well be that this arrangement has some relation to the orientation of the magnetic lines of force in interstellar space. It suggests the action, over long intervals of time, of forces that are unrelated to any particular stars.

6. Finally, Shajn and Hase have discovered several extraordinary filamentary nebulosities, such as the one in Auriga, pictured here, which they have aptly described as "a tangled ball of thread." The peculiar structure would seem to call for forces other than those that expel material from the outer layers of stars.

NEWS NOTES

By Dorrit Hoffleit

RECESSION FROM ORION

In March, we reported on the star AE Aurigae and its associated nebulosity, IC 405, that were found by A. Blaauw and W. W. Morgan, Yerkes Observatory, to have a space motion directly away from Orion. These same investigators have now found a star, Mu Columbae, moving away from the Orion nebula, at the same speed of 127 kilometers per second, but in nearly the opposite direction to AE Aurigae.

Extrapolated backward, the present motions strongly suggest that both stars originated in the vicinity of the Orion nebula 2,600,000 years ago. They are very young, blue stars, that could hardly be older than this. At present they are each about 337 parsecs from their point of presumably common origin, which is 500 parsecs from the sun. The distance of AE Aurigae from the sun is 525 parsecs, while that of Mu Columbae is computed to be 675.

The details of this work were published in the July *Astrophysical Journal.*

RED, WHITE, AND BLUE SUN-TRACKERS

On September 14th, President Eisenhower dedicated the new station of the Central Radio Propagation Laboratory of the National Bureau of Standards, at Gun Barrel Hill, Colo. Three automatically tracking telescopes for observing the sun are the outstanding astronomical equipment at Gun Barrel Hill. One, painted red, operates at 460 megacycles; another, painted white, at 167; while the third, blue, will receive 80-megacycle solar radiation.

NEWS OF COMETS

An unusual comet was found on July 31st, in Draco, by W. Baade, of Mount Wilson and Palomar Observatories. Its orbit, calculated by L. E. Cunningham, appears to have the large perihelion distance of 3.9 astronomical units; it cannot come less than 3.9 times as far from the sun as the earth is. Now of the 15th magnitude, it is moving slowly inward in its orbit, and perihelion passage is not expected before August, 1955.

Another 15th-magnitude comet, discovered in Aquarius by G. Van Biesbroeck at Yerkes Observatory on September 1st, was then fading rapidly, as it was well past perihelion. Two expected periodic comets have been recovered in addition: Oterma 1942VII at Mount Palomar on August 30th, and Wirtanen 1948b at Lick Observatory on September 26th. Both are extremely faint, magnitudes 19 and 18, respectively.

HENRI MINEUR DIES

In May, one of the most eminent French astronomers, Henri Mineur, died at the age of 55. Except for wartime interruptions, he was director of the Institut d'Astrophysique of Paris since 1936. His main work was the theoretical analysis of stellar motions, and he will probably be best remembered for his investigation of galactic rotation, discovered by Oort. Working by other methods, Mineur found the sun to be 8,000 parsecs from the galactic center, moving around it in about 250 million years.

INDIAN SOLAR COOKER

Scientists in India have solved the problems of mass-producing a reflector-type solar cooker. The main component of the cooker is a 48-inch diameter parabolic aluminum reflector. At its focus is a device for supporting cooking utensils.

Among the technical problems that had to be solved were the spinning of aluminum sheets of large diameter and their anodizing; these processes were taken up for the first time in India for this project.

ASTRONOMERS TO MEET AT BERKELEY

The Astronomical Society of the Pacific and Section D of the American Association for the Advancement of Science will meet at the Leuschner Observatory, University of California, from December 27th to 30th. (No Christmas meeting of the American Astronomical Society is scheduled this year.) In addition to three symposia and sessions for papers, a trip to Lick Observatory is planned for the closing day, and arrangements are being made for demonstrations of the Morrison Planetarium in San Francisco.

On Monday, December 27th, Drs. A. R. Sandage and H. P. Robertson will present papers in a symposium on the red shift in the spectra of extragalactic nebulae. Spatial distribution of galaxies is Tuesday's symposium subject, which is scheduled as part of the third Berkeley symposium on mathematical statistics and probability. Participants are to be Drs. F. Zwicky, J. Neyman, E. Scott, and C. D. Shane. The symposium Wednesday afternoon will be on the distribution of stars in the H-R diagram, speakers to be Drs. B. Stroemgren, J. Greenstein, G. E. Kron, O. J. Eggen, and H. Johnson.

Following the society dinner on Wednesday evening, Dr. Bart J. Bok, Harvard Observatory, will present the vice-presidential address of Section D, on "The New Science of Radio Astronomy."

As part of the AAAS program, the Meteoritical Society will hold sessions on the 28th and 29th. Professor F. C. Leonard will speak on the classification of meteoritic minerals and on the distribution by weight of the meteorite falls of the world. Other members will give papers concerning meteors as well as meteorites.

IN THE CURRENT JOURNALS

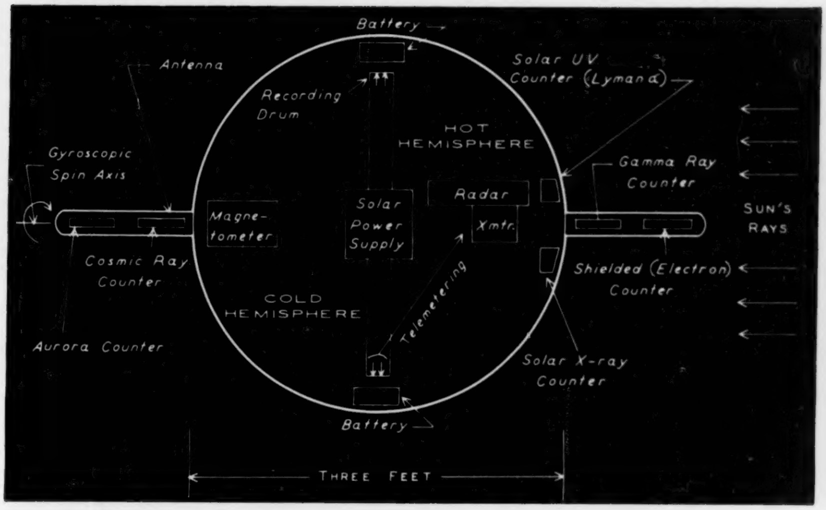
THE LAW OF RED-SHIFTS, by Edwin Hubble, **Monthly Notices,** Royal Astronomical Society, Vol. 116, No. 6, 1953. "Thus, if red-shifts do measure the expansion of the universe, we may be able to gather reliable information over a quarter of its history since expansion began, and some information over nearly a half of the history."

ELECTRONICS AND ASTRONOMY, by Guy Slaughter, **Radio-Electronics,** October, 1954. "...when sufficient numbers of amateurs start scanning the sky with TV sets or homemade receivers, their haywire directional antennas pointed heavenward, then radio astronomy, a new science born of a couple of older ones, will begin a rapid advance. It always happens that way."

THE NEAREST STARS, by Peter van de Kamp, **American Scientist,** October, 1954. "...the study of distant stellar systems has invigorated studies of our own system and has provided a new perspective on the nearest stars. The stars we see in other galaxies and those we can study in our immediate galactic neighborhood represent two different views of the inventory of stars. Both approaches are necessary and, it appears, complementary."

VIEWING THE ECLIPSE, 1860, by Olive Knox, **The Beaver,** Summer, 1954. "'This then is our success [wrote Simon Newcomb]. Three thousand miles of constant travel occupying five weeks, to reach by heroic endeavor the outer edge of the belt of totality; to sit in a marsh and view the eclipse through the clouds!'"

DESIGN OF THE LIFE COMPARTMENT NECESSARY FOR SPACE TRAVEL, by N. R. Nicoll, **Journal,** British Interplanetary Society, September, 1954. "This yields the rather surprising fact that the life compartment necessary for space travel weighs less than one ton, which leaves available two tons for scientific apparatus, power supplies, control equipment and crew."



The Mouse, an artificial satellite of the earth proposed for observations from 190 miles above its surface, is shown here schematically. The automatic instruments, powered by lightweight solar batteries, will transmit their readings by radio to ground stations.

THE MOUSE

A MODEST earth satellite, man-made, that could be launched within a few years, was proposed by Prof. S. F. Singer, of the University of Maryland, at the American Museum-Hayden Planetarium symposium on space travel last spring. The MOUSE (Minimum Orbital Unmanned Satellite of the Earth) would circle the earth about 190 miles high, perhaps for only a few days, and would weigh about 100 pounds. Instruments for astrophysical and other observations would record data from altitudes rarely reached by today's rockets, and for a longer period than the three to five minutes available on rocket flights.

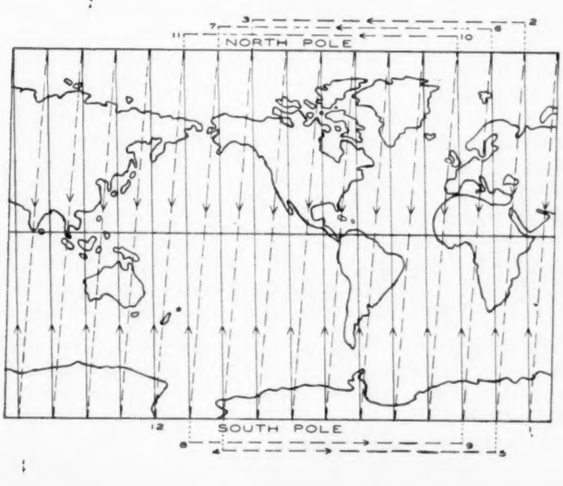
The proposed orbit of the Mouse is perpendicular to the equator and perpendicular to the line joining the earth and the sun. The satellite would cross the north and south poles and always be over places at which the local time was 6 a.m. or 6 p.m. This orbit is unique in allowing continuous observations of the sun, Dr. Singer pointed out, and also in covering the whole range of latitudes, important for determining the energy spectrum of incoming cosmic radiation. The rocket would also traverse the auroral zones around both geomagnetic poles. At an altitude of 300 kilometers (about 190 miles), each circling of the earth will take about 90 minutes.

The proposal is for a three-step rocket, with a few pounds of payload, the ability to do something useful with only this few pounds making the whole project worthwhile. The first step is planned to take the satellite vertically through the lower atmosphere and to begin its inclined flight. The second step will take over immediately after burnout of the first stage, in order to reach the required altitude and direction of motion. The third step simply boosts the velocity up to its orbital value. At the point of burnout or fuel cutoff (controlled from the ground), the nose tip will open and the spinning sphere which is the Mouse itself will begin to describe a relatively stable orbit around the earth. The spin axis will always be horizontal and at right angles to the direction of motion of the center of gravity. Conservation of angular momentum will keep the spin axis oriented without further controlling forces. If the sphere carries small curved blades, the slight drag of the earth's atmosphere at that height will tend to maintain the rotation.

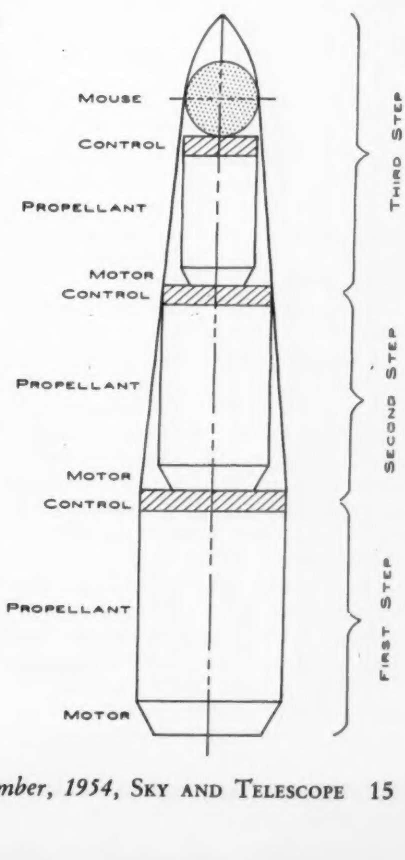
The observing instruments would be mounted in the two short tails along the spin axis, as the diagram shows; the orientation of the instruments would thus stay fixed in space. The tails would also act as antennae for the transmitter inside the sphere to telemeter observational data to ground receiver stations.

Now that extremely small solar batteries have been developed, Dr. Singer proposed that these could be used for the Mouse power supply, thus reducing the weight of the Mouse and permitting more instrumentation. The power might also be used to control its mo-

(Continued on page 17)



Left: The orbit of the Mouse is shown here projected upon a map of the world. Circling the earth 16 times per day, the vehicle is to pass over both poles on each trip.



Right: Dr. Singer proposes this three-stage rocket to carry the Mouse (shaded) aloft and place it in the desired orbit.

Amateur Astronomers

The Mid-States Convention of the Astronomical League

THE FIFTH annual Mid-States regional convention of the Astronomical League opened on September 4th at the Laws Observatory of the University of Missouri. The hosts were the Central Missouri Amateur Astronomers and the university mathematics department.

John Reed, the convention chairman, gave a short history of the observatory, acting on behalf of Dr. E. S. Haynes, the director, who was not able to be present. Founded just 100 years ago, Laws Observatory has a Merz and Mahler 7½-inch refractor that was purchased in 1875 and remounted in 1910. From 1940 to 1950 the observatory was closed. It now includes in its equipment a pulse-counting photometer. Much of the constructional and observational work during the past four years has been done by amateurs from Columbia and vicinity. The equipment is available for use by qualified persons.

Robert Follett, of Kansas City, spoke on making optical flats, using a pair of elliptical flats and a monochromatic testing box as demonstration apparatus. The undersigned presented some notes on Missouri meteorites, including the Archie and Baxter falls, in which people were struck by small "gravel" that accompanied the larger pieces, and the St. Louis fall of December 10, 1950, when a moving car was struck and its roof penetrated.

S. L. O'Byrne, of St. Louis, discussed the resolution of double stars, describing the work of H. H. Peterson (see the September issue, page 396). Mr. O'Byrne's revised formula for his 2-inch telescope gives a curve that closely parallels Mr. Peterson's dividing line between resolved and unresolved doubles for a 3-inch.

At the banquet, about 40 people heard Dr. Floyd Helton, director of the Morrison Observatory of Central College in Fayette, speak on "Some Historical Highlights in Astronomy." On the speakers' table was an illuminated rotating model of an observatory, constructed by Mr. Reed for the Laws 100th anniversary. The remainder of the evening was devoted to celestial observations.

On Sunday afternoon, two films were shown, one on the manufacture and uses of carborundum, the other on glass making. Joseph Smith, Kansas City Astronomy Club, was elected representative to the Astronomical League council; Mr. Follett became regional chairman; James Boyd, St. Louis Amateur Astronomical Society, was elected vice-chairman. Mr. and Mrs. J. Stewart, of the Tulsa Astronomical Society, will serve jointly as secretary-treasurer.

Mr. Reed proposed that a center be set up for the speedy dissemination of astronomical and related observations and information. It was decided to form the Mid-States Astronomical Reporters, as part of the regional organization. It is expected that a network of radio communication, operated by several radio amateurs who are now members of the region, will handle reports of aurorae, fireballs, comets, and unusual meteorological phenomena.

Ad-lib reports were given of the group work being done in each society. Much observational and public activity was evident. A new society has been added to our region this year — the Arkansas Amateur Astronomical Society, with C. G. Pool, of Little Rock, as secretary.

H. C. McComb, chief of the Columbia weather bureau, described equipment used for upper air soundings and displayed the airborne components: a neoprene balloon, paper parachute, and radiosonde transmitter. Afterwards, at the airport weather station, he gave a complete demonstration of the equipment. The following morning a number of people stopped at the weather station to watch the scheduled launching of the radiosonde balloon.

The evening meeting was at the Morrison Observatory. Still and motion pictures of the recent solar eclipse, made by various amateurs, were shown. L. Harrah, of the Central Missouri Amateur Astronomers, demonstrated WWV time-signal reception with the observatory's short-wave radio receiver. The film, The Story of Palomar, was shown, after which the delegates observed with the 12-inch Clark refractor and two 4-inch telescopes.

EDWIN E. FRITON
508 Marshall Ave.
Webster Groves 19, Mo.

BAKERSFIELD, CALIFORNIA

The Bakersfield Amateur Astronomers was organized two years ago and now has a membership of 16. Meetings are held the first Wednesday of each month in private homes.

In use at the present time are a 12-inch reflector, two 8-inch and two 6-inch reflectors, a 3-inch refractor, and a few smaller instruments. Under construction are two 10-inch, an 8-inch, and three 6-inch reflectors. We are a member of the Association of Lunar and Planetary Observers, with our chief activities centering on planetary observing and meteor photography.

GARY W. SCHMIDT
Secretary-treasurer
1700 Quincy St.
Bakersfield, Calif.

SOUTH BEND, INDIANA

A three-page publication called the *Monthly Observer* has been put out this year for members of the St. Joseph Valley Astronomical Society. The society is open to anyone interested in astronomy, and we have members varying in age from 11 to those old enough to have seen Halley's comet. We meet once a month in the South Bend YMCA, except during the summer when we have numerous observation meetings.

The society has the use of the 6-inch refractor at St. Mary's College. Richard Foltz has built a 4-inch refractor with clock drive, and Ben Doktor constructed a 12½-inch reflector.

BRUCE A. LOVELL, secretary
R. R. 6, Box 61-A
South Bend, Ind.

THIS MONTH'S MEETINGS

Brooklyn, N. Y.: Brooklyn Institute of Arts and Sciences, 8:15 p.m., Academy of Music. Nov. 26, James S. Pickering, Hayden Planetarium, "Deep Sky Objects."

Junior Astronomy Club, 8 p.m., Public Library. Nov. 19, C. Cuevas, W. Glenn, and E. Oravec, "Expedition Blackout."

Chicago, Ill.: Burnham Astronomical Society, 3:30 p.m., Adler Planetarium. Nov. 14, Dr. A. E. Whitford, Washburn Observatory, "The Age of the Universe."

Cleveland, Ohio: Cleveland Astronomical Society, 8 p.m., Warner and Swasey Observatory. Nov. 12, Dr. Dean B. McLaughlin, University of Michigan Observatory, "The Planet Mars."

Dallas, Tex.: Texas Astronomical Society, 8 p.m., Lone Star Gas Co. auditorium. Nov. 22, John M. Hulme, "Conditions Necessary for Life on Other Worlds."

Minneapolis, Minn.: Junior Astronomy Club, 4:15 p.m., Public Library. Nov. 10, R. E. English, St. Paul Telescope Club, "Amateur Telescope Making." Nov. 24, Craig L. Shurr, "Modern Observatories."

New York, N. Y.: Amateur Astronomers Association, 8 p.m., American Museum of Natural History. Nov. 3, Hans H. Rey, "A New Way to Look at the Stars."

Oakland, Calif.: Eastbay Astronomical Society, 8 p.m., Chabot Observatory. Nov. 6, Mrs. Natalie Leonard, "New Findings About Galaxies in the Light of Cosmology."

Teaneck, N. J.: Bergen County Astronomical Society, 8:30 p.m., Observatory, 107 Cranford Pl. Nov. 10, Shirley I. Gale, Hayden Planetarium, "Origin and Destiny."

A New Observatory at Reno

The new Blair Observatory has a sliding roof over the telescope. In this picture the roof has been rolled back to permit observations. Photograph by Allen Ramsey.

RECENTLY, the Astronomical Society of Nevada, in conjunction with the University of Nevada, has completed a project to which the late Prof. G. Bruce Blair had given the original impetus. This was the construction and equipping of an observatory on the university campus for the use of astronomy students and the amateurs of the locality. Professor Blair served as first president of the society, which was organized in 1935.

The Blair Observatory building was constructed by the university with funds left for astronomical purposes in the will of Mrs. Lilyan W. K. Darlington, a member of the society. It is of the roll-off roof type, the roof of the observing room sliding completely under the roof of the astronomer's office to provide clear access to the useful portion of the sky.

Members assigned themselves the task of providing the telescopes, and many gave generously of their time and money. Ultimate success would not have been achieved without the major efforts of Mrs. Blair, Dr. E. W. Harris, of the university, and Carl E. Wells.

The main telescope is a refractor constructed by Mr. Wells, with a Zeiss 150-mm., f/15 objective. The Haines mounting is supported on a massive concrete pier that extends three feet below grade and is isolated from the surrounding floor. The mounting is equipped with electric drive for the polar axis and electric driving motors for slow motion in right ascension and declination. The 13-inch setting circles are graduated to one minute of time and one-quarter degree of declination. A variety of eyepieces and a Barlow lens give magnifications from 75 to 540.

Other telescopes owned by the society include a 6-inch reflector donated by Dr. R. Thompson and a 4-inch refractor, believed to have been built by Brashear, donated by Dr. John L. Adams.

The Astronomical Society of Nevada meets regularly on the third Thursday of each month from September through May in the Mackay Science Hall at the University of Nevada.

BENJAMIN O. MOORE, JR., president
Astronomical Society of Nevada
328 Flint St., Reno, Nev.

New Colorado Society

AFTER many years of astronomical inactivity, the foundation has finally been laid for a continuing place in the community life for our chosen interest. Perhaps the greatest impetus was given by Marvin K. Knudson, president of Pueblo College, when he decided to institute classes in astronomy in the school curriculum. As a result, an evening adult education class was held during the winter quarter last year, followed by a regular day class during the spring quarter.

Not having any instrumentation or equipment for the courses, officials of the school approached me for advice. Apparently they came to the right place, since an idle 9-inch, f/11 Newtonian reflector was on hand which would at least serve as basic equipment until it was found whether or not the courses would "take" and justify the purchase of a better telescope.

Thus, the chain of events started which led to the formation of the Pueblo Astronomical Society. Although not a teacher by profession, I was invited to instruct the adult evening class, which had 15 students. The climax of this course probably came when an open house was held for observing, for which the class had also prepared an interesting exhibit, with blackboard drawings, topped off by a large display of astronomical photographs (my file of *Sky and Telescope* served admirably for this purpose). Imagine our surprise when instead of the dozen or two people expected, a crowd of about 300 responded, and the majority seemed to be genuinely interested.

At the conclusion of the quarter's work, students and instructor felt that the period together had been far too short, so at our last class session the organization of the Pueblo Astronomical Society was accomplished. Meetings were set for the first Monday of each month at my private observatory, Doreddie, with mid-month observing meetings as called. The membership roster now stands at 22 persons. Officers for the year include Mrs. Laurene Garrett, vice-president; Mrs. Marjorie Struthers, secretary; E. L. Vanderburgh, treasurer. Mr. Vanderburgh is a member of the mathematics faculty at Pueblo College, and the instructor in astronomy for the day classes.

E. D. ONSTOTT, president
Pueblo Astronomical Society
2421 Second Ave.
Pueblo, Colo.

Between Macrocosm and Microcosm

From cosmic dust and glowing gas;
From fiery suns in spiral mass,
The dark earth, haunted with a plan
Of life, emerged and brought forth man.

What creature this, who turns away
From mundane needs in solar day,
And with a billion light-year reach
Gleans knowledge, his quick mind to teach.

He analyzes spectral bars
Refracted from the light of stars
Of eons past, and by their trace
He limns the curved shape of space.

He plots the track the comet burns
And knows he'll die e'er it returns,
And yet with strange, ecstatic bliss,
He glories in computing this.

Prodigious man from atoms spun
With mind more puissant than his sun
Can leap in thought through stellar night
With speed transcending that of light.

MIRIAM S. ALTERMAN

THE MOUSE

(Continued from page 15)

tion and maintain the satellite in its orbit for periods even longer than a few days.

Based on published information, Dr. Singer estimates the entire cost of five Mouse satellites with their three-stage rockets as around five million dollars. If the five were produced in assembly-line fashion, the unit cost would be about a million dollars. He pointed out that a large bomber costs about 15 million dollars, and that the cost of conventional high-altitude rocket research is $100,000 per minute of flight time. He stressed that the project could be started right away, that it would require government backing since it involves large rockets, guidance, logistic support, and the like, but that private funds might well support the design and construction of the nonsecret Mouse vehicle itself. The International Geophysical Year, 1957, was suggested as a target date.

The scene at Stellafane on the afternoon of August 21, 1954, as cloudy skies gradually cleared away for a perfect evening of observing. All photographs with this article are by Bernard L. Lashua, Springfield, Vt.

STELLAFANE CONVENTION - 1954

THE MECCA of eastern amateur telescope makers has long been Springfield, Vt., for the convention at Stellafane atop Breezy Hill. Begun during the 1920's, these meetings were held nearly every year for two decades, and this summer the sequence was resumed. Under the joint sponsorship of the Springfield and the Boston telescope making groups, about 250 persons attended the convention on Saturday, August 21st, bringing with them more than two dozen telescopes.

Very appropriately, the convention opened with 10 seconds of silence in memory of Russell W. Porter, the guiding spirit of the old gatherings. The program featured remarks by Mrs. M. W. Mayall, AAVSO recorder, on variable star observing as a way of using a telescope after making it, some reminiscences by E. V. Flanders, of Springfield, on the early days of Stellafane, and an account by Dr. C. H. Smiley, Ladd Observatory, of chromoscopes and axicons. These unusual optical elements offer most interesting possibilities to the advanced telescope maker.

Also heard were "Wally" Everest,

T. J. Ryan, Brooklyn, N. Y., stands behind while others inspect his f/5, 6-inch reflector.

This enormous pair of 7-inch Japanese binoculars was exhibited by R. K. Dakin, of Pittsford, N. Y.

veteran telescope maker, Dr. Henry E. Paul, of Norwich, N. Y., and Dr. Leon A. Storz, chairman of the Northeast Region of the Astronomical League.

During the course of the program, amateurs from various points selected at random were asked to rise and identify themselves. All those from Canada were called upon. The registration book showed that 17 societies were represented.

The telescope competition was divided into two parts; instruments were judged for design and mounting in the afternoon, and in the evening for actual performance. The co-chairmen of the panel of 14 judges were Dr. Smiley and J. E. Lovely, of Springfield.

First prize in the design class went to Albert I. Robinson, Newton Centre, Mass., for his 6-inch f/10 reflector. The brass-fitted bakelite tube can be rotated in its saddle without disturbing an object in the field of view. The telescope is fitted with flexible-cable slow motions, and has brass setting circles eight inches in diameter. A. L. Dounce, Rochester, N. Y., gained second prize with his 8-inch reflector, so large that he transported it on a trailer. Other prize winners were W. E. Knight, Brighton, Mass., S. M. Gardiner, East Weymouth, Mass., and G. Carlson, Trumbull, Conn.

Every one of these old-timers has attended 10 or more conventions at Stellafane. Left to right, they are W. Shattuck, Wollaston, Mass., Dr. C. H. Smiley, Providence, R. I., E. V. Flanders, Springfield, Vt., C. Moulton, Springfield, Mass. (rear), W. Hargbol, Belmont, Mass., A. W. Everest, Pittsfield, Mass., G. A. Perry, Springfield, Vt., Dr. D. G. Knecht, Allentown, Pa., J. M. Pierce, Springfield, Vt., C. Cook, Lexington, Mass., John C. Pierce, Plainfield, Vt., P. Allen, Orange, N. J., C. R. Ranney, Springfield, Vt., C. C. Young, East Hartford, Conn., and G. A. Rettenmaier, Orange, N. J.

After dark, Mr. Dounce's instrument outperformed all the others, while second prize went to E. A. Johanson, New York City, and the third award was split between Mr. Knight and D. L. Brunell, Foxboro, Mass.

It was a fine night, with seeing 8 on a scale of 10 best, so that an enthusiastic observing session took place. A display of northern lights added interest to the program.

The convention was planned by a committee composed of J. W. Lovely, J. H. Beardsley, and C. R. Ranney, for the Springfield Telescope Makers, and C. Cook, J. W. Gagan, and Mr. Gardiner, for the Amateur Telescope Makers of Boston. Charles A. Federer, Jr., acted as master of ceremonies.

Already plans are being made for the next meeting, to be held on August 20, 1955.

Left: The 8-inch electrically driven reflector by A. L. Dounce, which won first prize for observing performance and second prize for design. Center: The first prize for design went to this 6-inch reflector by A. I. Robinson. Right: This 6-inch f/8 instrument by E. A. Johanson won second prize for performance.

AMERICAN ASTRONOMERS REPORT

Here are highlights of some papers presented at the 91st meeting of the American Astronomical Society at Ann Arbor, Mich., in June. Complete abstracts will appear in the Astronomical Journal.

Auroral Excitation

At Yerkes Observatory, Drs. C. Y. Fan and Joseph W. Chamberlain have been studying the physical and chemical processes taking place in the upper atmosphere that produce the visible light of the aurora. Dr. Fan has studied spectra of aurorae of different types, particularly homogeneous bands and arcs as distinguished from rays and draperies. Invariably his spectra of quiet arcs show the red hydrogen-alpha line, caused by hydrogen nuclei (protons) that enter the atmosphere, presumably from the sun. But on no occasion do the rayed structures show hydrogen lines, yet they do show bands of nitrogen that is apparently excited to shining by the energy of electrons.

Thus, Dr. Fan concludes that although arcs may be produced by protons from the sun, rayed features are due primarily to electron excitation. But electrons, because of their small mass and momentum, cannot easily penetrate the atmosphere down to auroral altitudes of about 100 kilometers; therefore, they are probably accelerated within the atmosphere itself by a difference in electrical potential between two layers — they use energy stored in the form of electrostatic potential.

Dr. Chamberlain has studied the theory of auroral production by high-energy incident protons. When the protons enter the atmosphere with velocities of the order of 10,000 kilometers per second, they are traveling too fast to capture electrons and produce radiation. But collisions slow the protons, which steal electrons from oxygen and nitrogen atoms in the air, also causing the latter to become excited and to radiate characteristic auroral lines. At very low speeds, the excitation ceases rather suddenly; consequently, auroral arcs have fairly sharp lower borders, fading off gradually toward high altitudes.

Each proton produces about 50 quanta of hydrogen-alpha radiation by successive captures and losses of electrons. From this value, Dr. Chamberlain estimates that an average auroral arc results from an influx of between 10^7 and 10^8 protons per square centimeter per second.

The arcs are too wide for the protons to be entering the atmosphere only along lines of magnetic force. Their velocities also indicate that the distribution of incoming directions is quite broad, with an appreciable number of particles entering at 60 to 70 degrees from the direction of the magnetic lines of force (the magnetic zenith).

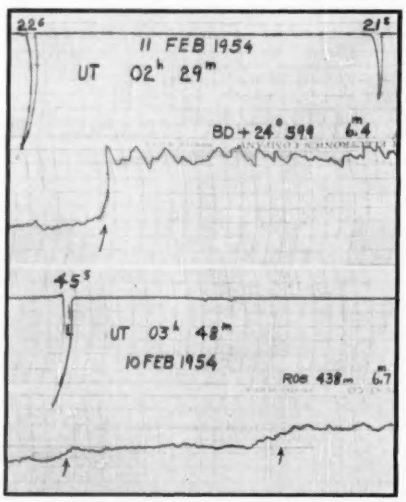
Photoelectric Observations of Occultations

Occultations of stars by the moon, if timed very accurately from several stations, can provide the data for a more exact determination of the size and shape of the earth. An extensive field trial of the method was carried out by the Army Map Service between December, 1953, and April, 1954, when 33 occultations were observed by three parties in the southwestern states.

Each team had a mobile 12-inch Cassegrainian reflector, equatorially mounted and with an electric drive. Starlight was measured with a 1P21 photomultiplier tube and Brush amplifier, whose output was recorded by a dual-channel oscillograph. This last also recorded WWV time signals.

Two of the records obtained are reproduced here in part. For the star BD +24°599, the deflection drops abruptly as the star is covered by the advancing edge of the moon. The irregularities of the tracing are much reduced after the star has disappeared, showing that these vagaries are mainly caused by the twinkling of starlight.

The second example, the lower half of the illustration, shows two drops in the tracing as it proceeds from right to left. It records how the moon covered



These two photoelectric records of occultations were made by the Army Map Service. The radio time signals are labeled. The second star, a double, was occulted in two steps.

first one component and then another of a close double star, ADS 2273. The method can be used to discover double stars, and S. W. Henriksen reported observations of 63 Geminorum on April 10, 1954, from three widely separated points in the Southwest. Measurements of the recordings indicate the probable presence of a companion star; its magnitude is estimated about 7.8 relative to the main component (5.3) and its separation only 0.05 second of arc, projected upon the direction of the moon's motion.

George W. Preston summarized the results. He pointed out that disappearances of stars behind the dark limb of the moon could be observed to within 0.02 second of time in routine operations, and stars as faint as the 9th magnitude could be used. When the lunar profile becomes known more exactly, these observations will yield very precise positions of the moon.

Brightness of Pluto

At the Lowell Observatory, Dr. Robert Hardie has been engaged in the photoelectric photometry of faint objects with the 20-inch reflector. Among his results is a new determination of the magnitude of Pluto as 14.50, from measurements on three nights, May 5-7, 1954. This value is for yellow light, on the Johnson-Morgan system, and thus corresponds very nearly to the visual magnitude.

Other observations, of the variable star RV Lyncis, show that the Lowell 20-inch telescope can make usable photoelectric measurements of stars as faint as magnitude 16.2 in blue light.

H_2O Clouds on Venus?

In recent years, astronomers have considered seriously the possibility that the clouds that veil the surface of the planet Venus consist of dust rather than water or some other form of vapor. The dust hypothesis, however, is inconsistent with polarization measures of Venus' light by B. Lyot, and these measurements fit the behavior of light scattered by clouds of water droplets.

Recent measures of the planet's temperature by William Sinton indicate a nearly constant day-night value of —39° centigrade for the visible surface of the clouds. At this low temperature, the atmosphere of Venus above the cloud layer could contain very little water vapor, so the lack of water-vapor bands in the spectrum of Venus does

not support an argument against the clouds themselves being composed of H_2O.

At Harvard Observatory, Drs. Donald H. Menzel and Fred L. Whipple suggest that the surface of Venus may be covered by water and its clouds composed of the same substance (liquid or frozen). The atmosphere of Venus consists largely of carbon dioxide, which could not exist on an earthlike planet with continents protruding. H. C. Urey has shown that the CO_2 would be fixed in the rocks in the form of carbonates because of its chemical reaction with silicates in the presence of water. But if the surface of Venus is completely covered with water, the fixation of CO_2 could not continue after the formation of a thin buffer layer of carbonates, and its atmosphere could remain largely carbon dioxide supporting water-vapor clouds.

Yellow Coronal Line

Theoretical calculations have been made by Dr. H. Zirin, Harvard Observatory, of the expected wave lengths of some spectrum lines of Ca XV (calcium atoms from which 14 electrons have been removed), and of similar ions. He finds that the wave length of the strong yellow line of Ca XV should be 5480 angstroms, confirming a recent extrapolation by Garstang; this differs greatly from the observed wave length of the yellow line in the sun's corona, 5694 angstroms. Hence the yellow coronal line, which D. E. Billings attributed to Ca XV *(Sky and Telescope,* June, 1954, page 252), may be due to some other ion.

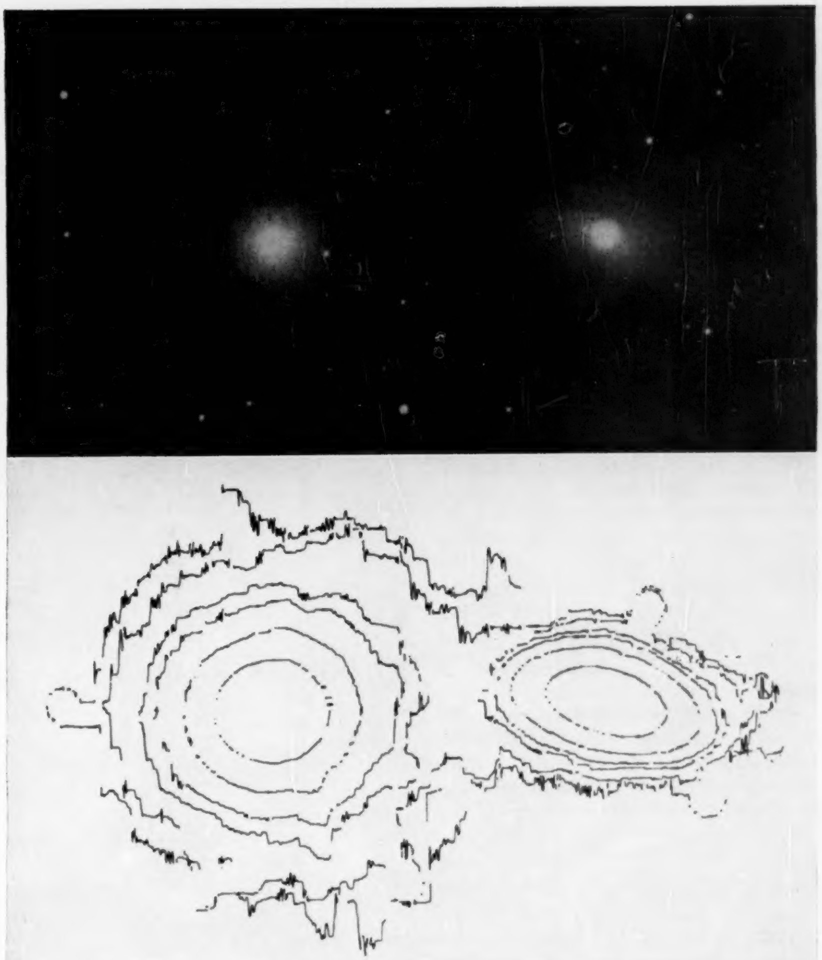
Distribution of Brightness in Galaxies

In studying the structure of a galaxy it is useful to chart the contours of equal brightness, a very laborious task by older methods, but rapidly performed with high accuracy by the recording microphotometer of the University of Michigan Observatory. Edwin W. Dennison has used this instrument to measure photographs of two galaxies obtained with the 24-inch Curtis Schmidt camera at Portage Lake, Mich., and with the Mount Palomar 200-inch reflector.

One of the galaxies, NGC 3379, is type E0 according to E. P. Hubble. It was found that while the inner and outer contours are nearly circular, those for the main body of this galaxy are somewhat elliptical. Evidently the shape of a galaxy is less simple to characterize than is often supposed.

The other object examined is the barred spiral (type SBa) NGC 3384, which appears on the same plates as NGC 3379. Here the ellipticity is most marked for the outer contour lines, and is considerably less for the inner. The steepest fall-off of intensity occurs some 100 seconds of arc from the center—far outside the bar structure.

These results seem to indicate that elliptical and barred spiral galaxies have significantly different internal structures.



Two galaxies in Leo, photographed in red light with Michigan's 24-inch Schmidt telescope, exposure one hour. At the left is NGC 3379, an elliptical galaxy of photographic magnitude 10.8. The other is the barred spiral NGC 3384, magnitude 11.3, but the bar is not recognizable in the burnt-out inner region. The field shown is nine by 17 minutes of arc in size. The lower part of the picture shows contours of equal brightness for these objects, obtained by E. W. Dennison; these show that the outer regions of the galaxies appear to overlap.

P Cygni-type Stars

At Harvard Observatory's Boyden station, Henry J. Smith has studied 11 stars of the P Cygni type in the Large Magellanic Cloud. Spectroscopic observations were made, as well as photoelectric measurements of brightness in three colors. The mean apparent magnitude of the 11 stars, 11.6, corresponds to an absolute magnitude of −7.1, when A. D. Thackeray's recent determination of the distance of the cloud as 55,000 parsecs is adopted.

These intrinsically very luminous stars are also very blue, and Mr. Smith points out that this may allow their recognition in other nearby galaxies.

Evolution of a Star Cluster

The MANIAC at Los Alamos Scientific Laboratory is an electronic computer whose speed is some 10,000 times that of a desk machine operated by an exceptionally skilled calculator. Dr. Ralph E. Williamson reported on a number of astronomical and astrophysical calculations performed by MANIAC that were too complex for attack by earlier means.

One such problem, run on the MANIAC by S. Ulam and J. Pasta, dealt with a two-dimensional cluster of 100 stars. Their motions have been studied with a time-scale such that one minute of computation covers 10 mil-

lion years in the life of the cluster. At each time-step, every star was moved by calculating the result of the gravitational attraction on it of all the other cluster stars.

In the course of the run, some stars were lost from the cluster, some double and multiple systems were formed, and certain fairly persistent clumping tendencies were noted.

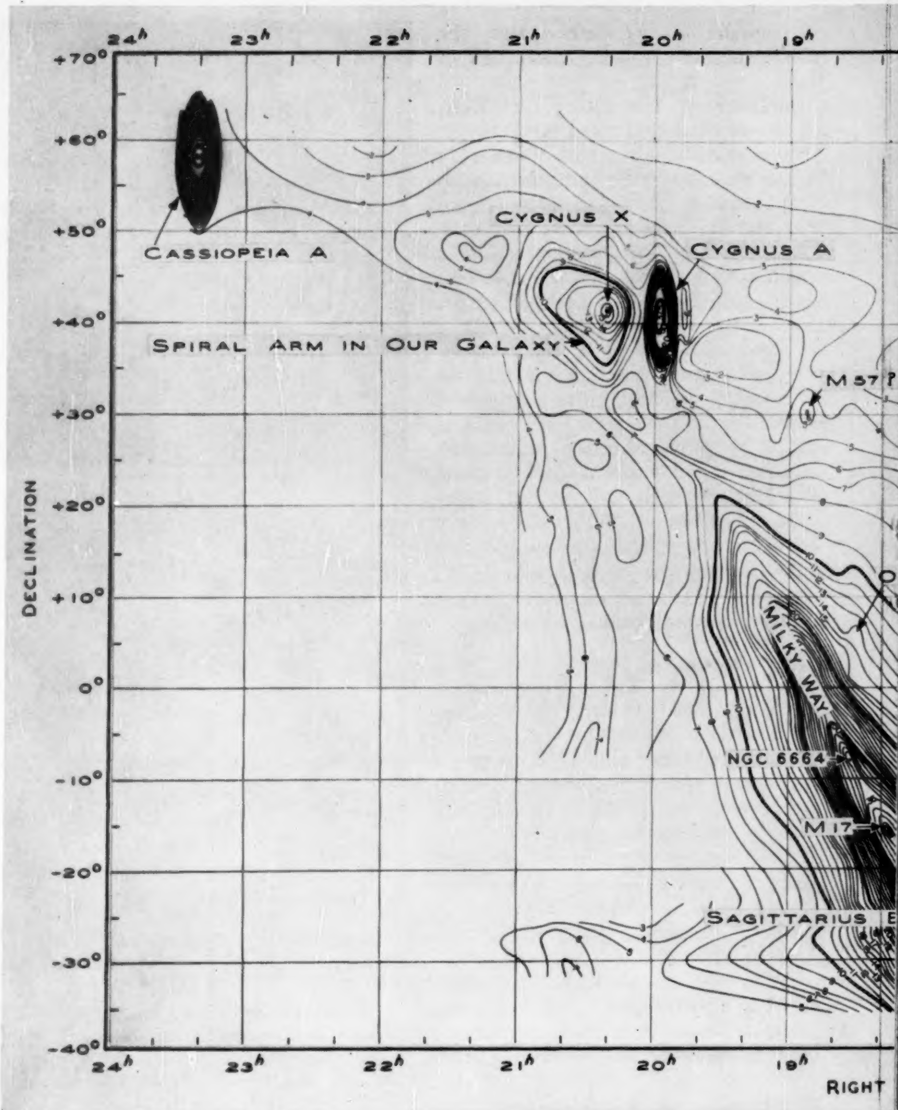
Dr. Williamson remarked that, in a sense, modern electronic computers have brought the scope of the universe, in both time and space, within the realm of direct observation.

Radio Map of the Milky Way

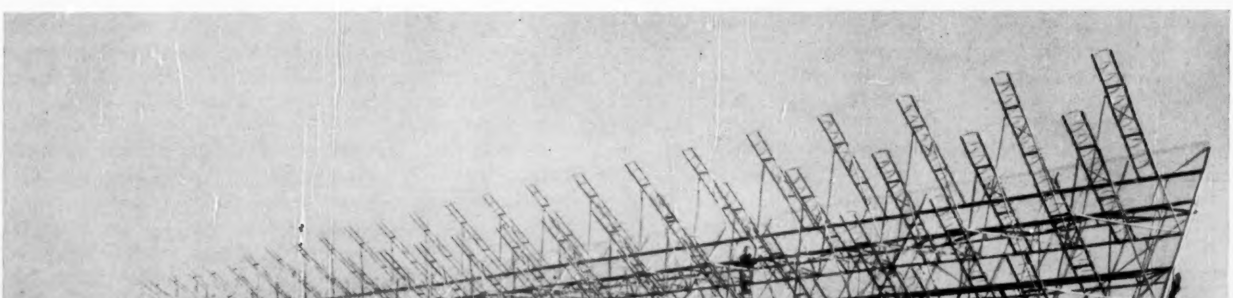
The detailed structure of the Milky Way, as viewed with radio noise of 1.2 meters wave length (250 megacycles) has been studied by Drs. J. D. Kraus and H. C. Ko at Ohio State University. They used the radio telescope pictured here, which is twice as large as it was when described by Dr. Kraus in the April, 1953, issue of *Sky and Telescope*. At that time it had 48 helices; it now has 96.

From observations made in the spring of this year, the Ohio radio astronomers have prepared the accompanying contour map, the nearest approach to a "radio photograph" of the sky yet made. It suggests how the heavens might look if our eyes were sensitive to radio waves instead of to light, and had the same resolution and antenna pattern as the Ohio radio antenna. In the map, however, the elongated shape of the bright sources is fictitious; it results from the fact that the antenna pattern is one degree wide in right ascension and eight degrees high in declination.

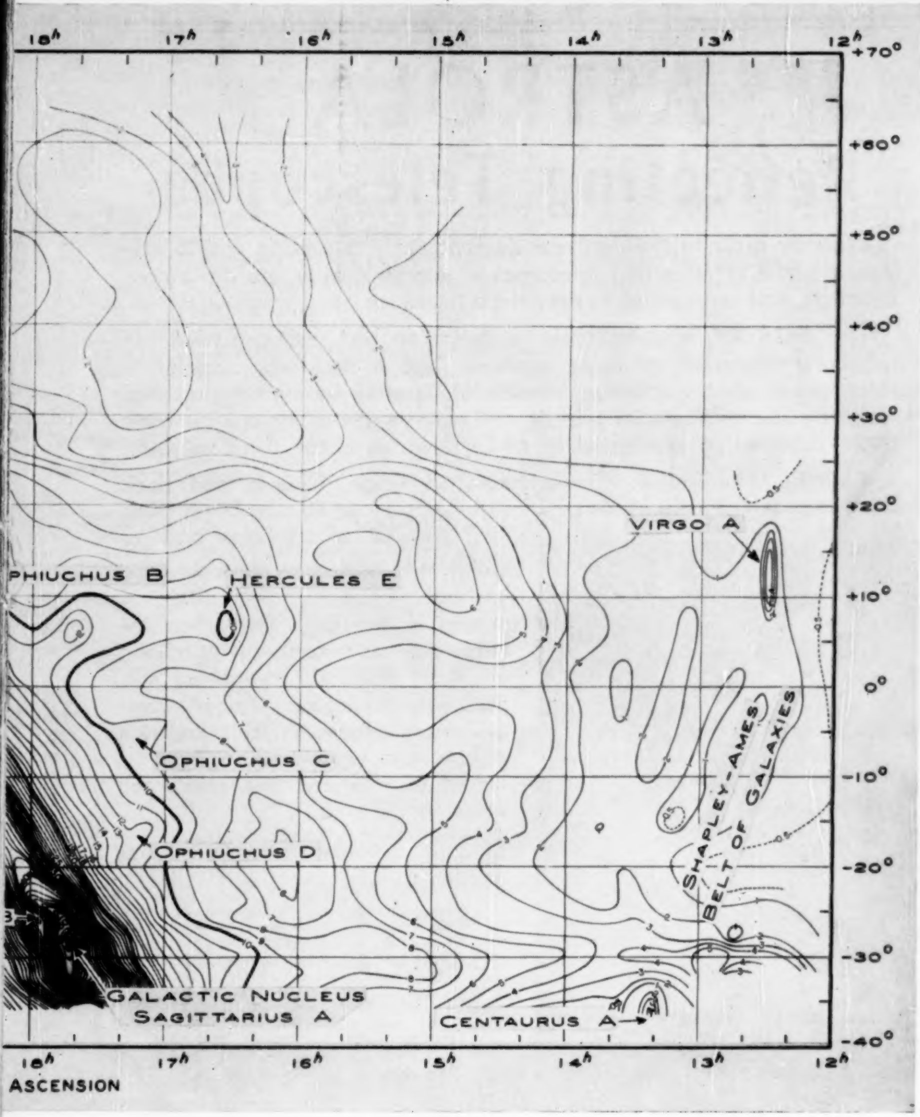
The antenna was set at a fixed declination for several days and a record (or profile) of the cosmic radio back-



The Ohio State radio map of the summer sky, in which the contours are lines of equa
much more prominent toward the galactic center than it is optically becau



The recently enlarged radio telescope of Ohio State University uses 96 helical antennas to pick up radio signals from the depths of the Milky Way. The entire array can be tilted around a horizontal axis.

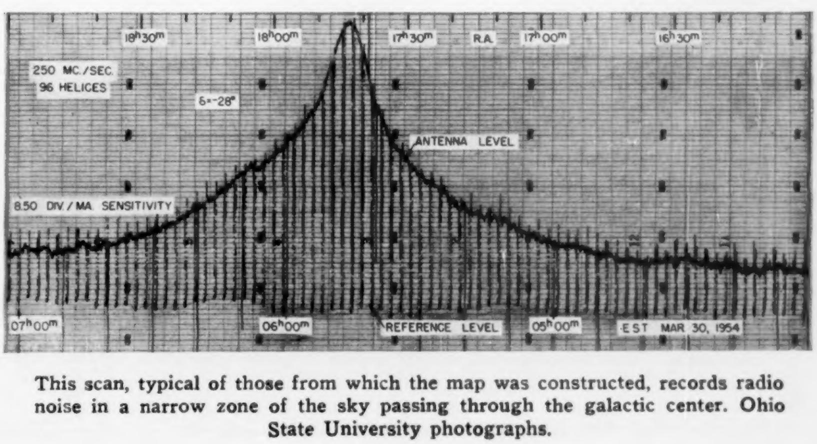


l intensity. The more localized sources (radio "stars") are labeled. The Milky Way is se the radio waves pass unhindered through the intervening interstellar dust.

ground was obtained as a function of right ascension for a narrow zone of declination. A sample profile, for declination —28°, is shown here. It crosses the center of the galaxy in Sagittarius and shows the concentrated and symmetrical character of the nucleus at this wave length. The map is built up from a number of such profiles.

Cassiopeia A is the strongest radio source, and next is Cygnus A. The latter has been identified by Baade and Minkowski with a pair of colliding galaxies 200 million light-years distant. While to the radio telescope this feature dominates the Cygnus region, photographically the galaxies are only magnitude 18!

The peak of intensity on the entire map is Sagittarius A, the galactic nucleus. Dr. Kraus places its position, in 1950 co-ordinates, at $17^h\ 42^m\ 48^s$, —28° 50′, corresponding to galactic longitude 327°.8, galactic latitude —1°.4.



This scan, typical of those from which the map was constructed, records radio noise in a narrow zone of the sky passing through the galactic center. Ohio State University photographs.

SKY AND TEACHER

(Continued from page 9)

The Milky Way, Bart J. Bok and Priscilla F. Bok. 1945. Our galaxy, star clusters, interstellar dust and gas, and problems related to the past and future of the galaxy are discussed.

The Story of Variable Stars, Leon Campbell and Luigi Jacchia. 1941, $3.50. The different kinds of variable stars, how they are observed, and what they reveal. The authors explain how the amateur with a small telescope can do worthwhile research in this field.

Telescopes and Accessories, George Z. Dimitroff and James G. Baker. 1945, $4.00. A full and understandable description of the observational tools of the astronomer and their underlying principles.

Atoms, Stars and Nebulae, Leo Goldberg and Lawrence H. Aller. 1943. A readable account probes the subject of modern astrophysics and discusses stars of different kinds.

Our Sun, Donald H. Menzel. 1949, $4.75. The nature of the sun, sunspots, solar influences on the earth, and eclipses are presented by the present director of Harvard Observatory.

Stars in the Making, Cecilia Payne-Gaposchkin. 1952, $4.25. An up-to-date account of what is known of the origin and evolution of the stars.

Galaxies, Harlow Shapley. 1943, $3.50. The story of the exploration of space outside the limits of our own Milky Way, narrated by one of the most active of its explorers.

Between the Planets, Fletcher G. Watson. 1941. Deals with meteors and meteorites, comets, and others of the smaller bodies in the solar system.

Earth, Moon and Planets, Fred L. Whipple. 1941, $4.75. A description of the planets and their atmospheres, with a planet finder and star chart included.

Other equally valuable works may have been omitted from this list, but it should be a useful check list of nontechnical titles in astronomy.

GRACE C. SCHOLZ, chairman
Astronomical League Book Service
166 Mason Hall Apts.
Alexandria, Va.

BOOKS AND THE SKY

GEORGE DAVIDSON
Pioneer West Coast Scientist

Oscar Lewis. University of California Press, Berkeley and Los Angeles, 1954. 146 pages. $3.50.

MIXED feelings of admiration and disappointment were my reactions to Oscar Lewis' book, the story of the man who conducted the first systematic geodetic survey of the Pacific Coast, built himself the first astronomical observatory of the Far West (1879), and inspired James Lick to provide for the largest observatory of the time.

The frontispiece is a pasted-in color reproduction of a portrait of the scientist, a picture such as has seldom graced books since the rapid rise of printing costs. The face of George Davidson is striking, and the portrait's chiaroscuro effect reminiscent of a Rembrandt. Other illustrations are printed in black and white near the center of the volume. They are all in good taste, clearly suggesting the era of the story, 100 to 50 years ago.

In contrast to these attributes are the subtitles and chapter headings printed in the "modern" technique without capital letters. The heading of the second chapter, "u. s. coast survey," strikes me as decidedly disrespectful.

George Davidson is described as "one of the most eminent scientists of his day and a leading spirit in the beginnings of organized scientific research in the West" whose present-day obscurity "is clearly undeserved." From the preface one gathers that the author had access to considerable unpublished material upon which to base a biographical sketch. Hence, it was with anticipation that I began reading about this versatile geodesist, astronomer, explorer, and historian. The 128 pages of text are followed by an excellent chronology, a list of Davidson's published writings, and an index.

To one especially interested in astronomical history of the late 19th century, a time when important American observatories were just beginning to grow, this book presents some choice selections of hitherto forgotten detail. The text, however, suffers from frequent repetition, and could have been materially shortened without loss of content.

Perhaps of greatest interest to readers of this department is the part Davidson played in the founding of Lick Observatory. In Webster's *Biographical Dictionary*, we find that he aided in determining the site, whereas the brochure on the observatory issued by the University of California, in its historical account, makes no mention of Davidson whatsoever. Lewis, however, tells us that it was Davidson, whose friendship Lick cultivated at the California Academy of Sciences, who first inspired the monument-financing Lick to erect a great observatory in the West. Indeed, Davidson was the one who persuaded Lick to give a large refractor rather than the 6-foot mirror originally favored. It was Davidson himself who made the necessary contacts with Alvan Clark for making the 36-inch refractor.

The philanthropist wanted the observatory to be right in San Francisco, but Davidson tried to have it on a peak at least 10,000 feet high. During the latter's absence in 1874-76 to Japan on a transit of Venus expedition and subsequent world tour, Lick decided upon the site on Mt. Hamilton. This was a compromise on altitude, but one that led Davidson to withdraw from further interest in the observatory project.

Incidentally, the one blunder found in the book occurs in the account which credits Davidson with having been the first to advocate high altitudes for astronomical observatories. He is quoted as saying, "At my mountain stations I have observed stars of the 6th magnitude with

a telescope that would not see the 7th in New England stations."

In San Francisco, Davidson heard of a butcher who was busily building himself a telescope. This man's qualifications he brought to the attention of a philanthropist, Anthony Chabot. Soon the butcher became the director of a new observatory. Moreover, the Chabot Observatory is claimed to be "the first astronomical observatory to become an integral part of the public school system of an American city."

While a wealth of anecdotes and scientific facts is assembled in this short book, the author does not seem to have gotten close to the personality and spirit of his subject. True, he tells us something about Davidson's personality and temperament, his early dissatisfaction with California for which he later acquired an affection, his sponsorship of science and social progress. But the author appears to have had too little direct contact with the sciences Davidson pursued to re-create the spirit of his work.

There are many quotations, but I wonder if the ones that might have been most revealing of the man's character have not been overlooked. More quotations like the excellent one on page 118, describing the problems of surveying parties on high unexplored mountains and subject to Indian attacks, would bring us closer to the scientist's own mode of thinking.

The author has, nevertheless, accomplished a great service in this book, certainly helping to retrieve the memory of an important public servant. Someday the material he has assembled should be more stimulatingly and extensively presented.

DORRIT HOFFLEIT
Harvard College Observatory

NEW BOOKS RECEIVED

THE ORIGIN AND HISTORY OF THE EARTH, *Robert Tunstall Walker and Woodville Joseph Walker*, 1954, *Walker Corporation*, Box 1068, Colorado Springs, Colo. 214 pages. $5.00.

Two mining geologists discuss the evolution of the earth upon the hypothesis that the earth is slowly increasing in volume, contrary to the generally accepted view that the earth's crust is shrinking. The phenomena of vulcanism and orogeny are reinterpreted on this new basis.

ECLIPSES IN THE SECOND MILLENIUM B.C. (−1600 to −1207), *G. van den Bergh*, 1954, *H. D. Tjeenk Willink & Zoon*, Haarlem, Netherlands. 101 pages. 15 guilders.

Prof. van den Bergh supplies data on 332 lunar eclipses and 590 central solar eclipses during the four centuries preceding Oppolzer's *Canon der Finsternisse*, which lists the eclipses of 1207 B.C. to 2161 A.D. The new calculations have been made with the aid of eclipse cycles discovered by the author. Maps of the solar eclipses are given. This book should be useful to the historian who uses records of eclipses to anchor chronologies.

LA PHOTOGRAPHIE ASTRONOMIQUE, *Julien Saget*, 1952, *Editions Prisma*, 7 Rue Scribe, Paris. 48 pages. No price given, paper bound.

This booklet is No. 42 in the series, Les Photos Guides, written in French. In addition to reproductions of many astronomical photographs, there are plans and pictures of amateur equatorially mounted cameras, and brief directions for photographing different types of astronomical objects.

THE NAVIGATOR'S POCKET ALMANAC 1955, *Paul E. Wylie*, 1954, *Institute of Navigation*, University of California, Los Angeles 24, Calif. 22 pages. $1.00, paper bound.

This almanac is intended for air and sea navigators and for surveyors. The principal tables give the Greenwich hour angles and declinations of the sun, four bright planets, selected navigational stars, and the vernal equinox during 1955, to an accuracy of 0.1 minute of arc. Other features are charts of navigational stars, and tables of altitude corrections.


Questar
Questar
PROCELLARUM
OCEANUS
Kepler
Copernicus
Aristarchus
Herodotus
IMBRIUM
SINUS
IRIDUM
EQUATOR
Hydra
40X

GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

Notes on Basic Optics — X

K. Prisms as Reflecting Surfaces

We have seen that mirrors are useful in optical instruments for bending the line of sight around corners and for orienting images. Most of these mirror arrangements can be duplicated with prisms. These have the advantages that the alignment of the reflecting surfaces to each other is "built-in" and will not be altered by temperature, vibration, and the like; and the reflectivity of the internal surfaces is essentially 100 per cent, while mirrors must have special coatings if their reflectivity is to be greater than 90 per cent. Where large sizes are involved, mirrors are generally used because they are much cheaper and lighter, and because of the difficulty of obtaining large, clear blocks of optical glass. Prisms with faces larger than about three inches are seldom seen.

1. **Total Internal Reflection.** Under certain circumstances, a clear glass surface can reflect 100 per cent of the incident light and transmit none. When light passing through a glass block falls upon a surface from the inside, it will be totally reflected if the angle of incidence (angle between the normal to the surface and the ray) exceeds a certain value, called the **critical angle.** At angles of incidence less than the critical angle only part of the light is reflected, the amount depending on the angles. The value of the critical angle differs for various types of glass; it is about 42° for ordinary crown glass. Explanation of this phenomenon can be postponed until we discuss the law of refraction.

Hence, to achieve total internal reflection at any internal prism face, the angle of incidence for crown glass must be greater than 42°. In a standard right-angle crown glass prism, light entering normal to one face will strike the hypotenuse internally at an angle of 45° and be totally reflected. For other types of prism and for light striking at smaller angles of incidence, heavier glasses are used, because they have smaller critical angles.

2. **Simple Prisms.** It would be impossible to discuss here all or even a majority of the many types of prisms that have been devised. We shall merely describe and illustrate a few of the more common types (Fig. 33).

The **right-angle** prism is frequently used in periscopes and elbow telescopes to turn the line of sight through 90°. Since it has only one reflection, it gives a left-handed image (explained in our September installment), and hence is usually used only when there is at least one other reflecting surface in the instrument. The amateur is familiar with its application as the secondary of a Newtonian reflecting telescope, where the prism and the finish on its surfaces must be perfect to give good results.

Two right-angle prisms can be com-

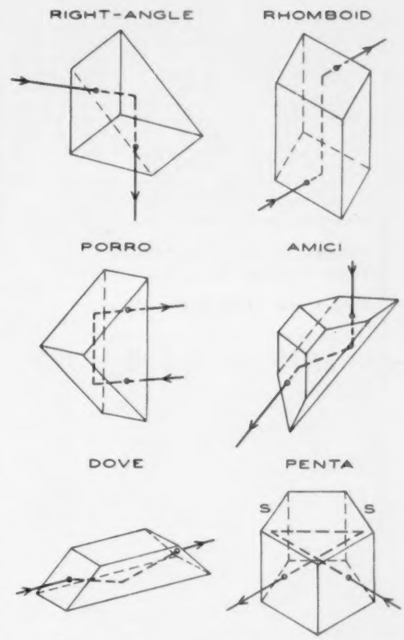


Fig. 33. The arrows show the passage of a ray of light through these prisms. Silvered surfaces are labeled "S."

bined to form a **rhomb** or **rhomboid** prism. It yields an erect image, and is used for displacing the line of sight parallel to itself.

The **Porro** prism is essentially two right-angle prisms back to back. It produces a left-handed image for it deviates the line of sight 180°. Two Porro prisms comprise the Porro erecting system, to be described below.

different arrangement of the Porro system. It is often called an **Abbe** system.

The **Leman** prism, also shown in Fig. 34, is used in a very small and compact type of binocular. The **roof-K** or **Brashear-Hastings** prism (not illustrated) is sometimes employed when the line of sight is to be kept undeviated.

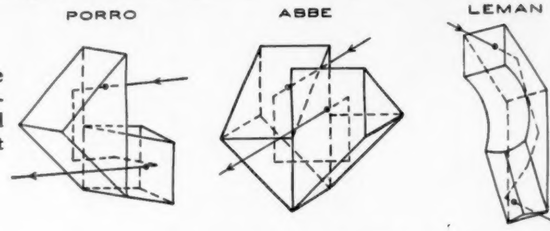


Fig. 34. A few of the prisms and prism combinations that are used to achieve an erect image.

The **Amici roof** prism produces a 90° deviation of the line of sight and gives a right-handed image. It is frequently used in elbow telescopes. The "roof" is at the right side in the diagram, and light striking one roof face is internally reflected to the other before leaving the prism. The angle of the roof must be accurate to close tolerances, usually to within one or two seconds of arc for fire-control and other instruments. During the war, the shortage of roof prisms was overcome by the concerted action of many amateur telescope makers in this country.

The **Dove** prism is frequently employed as a derotator. It satisfies the necessary conditions of left-handed image and 0° deviation of the line of sight.

The **penta** prism is another means for deviating the line of sight through 90° with a right-handed image. As is seen in Fig. 33, two of the reflecting surfaces have to be silvered because the light is incident at too small an angle from the perpendicular.

3. **Prism Erecting Systems.** As an image can be inverted by either prisms or mirrors, erecting systems frequently contain prisms, since the latter allow the instrument to be more compact. Binoculars are the most common instrument with an erecting system. They often have the Porro-prism system—two simple Porro prisms set at right angles to each other, as shown in Fig. 34.

Another common type of prism erecting system is seen to be merely a slightly

4. **Prisms of Small Deviation.** To turn the line of sight by less than 90° requires quite large reflecting surfaces, and it is customary to use two or more reflections. Fig. 35a shows a method for procuring a right-handed image deviated 60°, and Fig. 35b illustrates the principle of the **delta** prism, which produces a left-handed image.

5. **Derotating Prisms.** A prism with a left-handed image and a 0° deviation of the line of sight has the property of double-speed image rotation explained in September, and so it is used in optical instruments for correcting image rotations that may result from scanning. For this purpose several different prisms may be used.

Three varieties are the simple Dove prism (Fig. 35c), with one reflection; the delta prism (Fig. 35d), with three reflections; and the Schmidt prism (Fig. 35e), which has five reflections.

Fig. 36 shows a panoramic telescope,

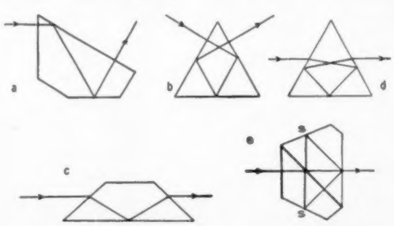


Fig. 35. Prisms for small deviations and for derotation of the image. Silvered surfaces are labeled "S."

used as an artillery gun-sight, which has a right-angle prism at the top for scanning. As this prism turns in scan, the image rotates. This rotation is corrected by a Dove prism, which turns at half

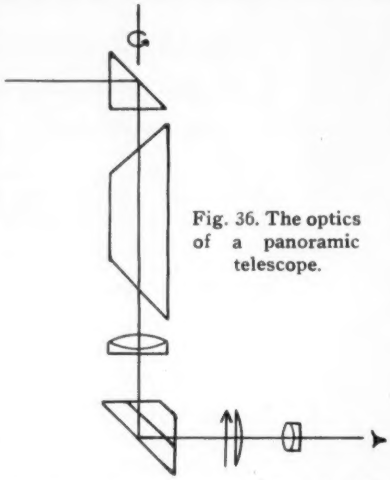


Fig. 36. The optics of a panoramic telescope.

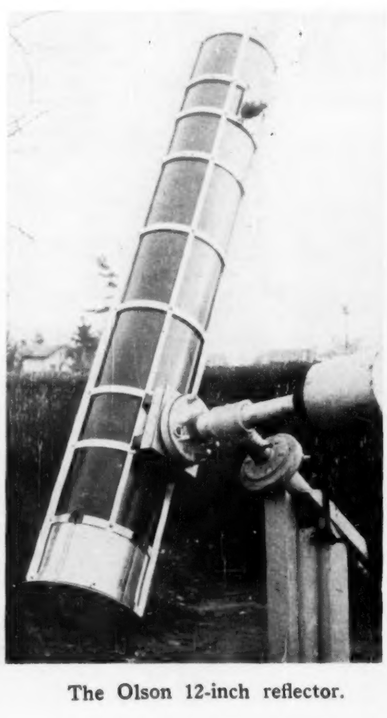
the scanning-prism speed. Next the light passes through an elbow telescope containing an Amici prism, which has the double function of bending the line of sight and erecting the image.

(To be continued)

A 12-INCH REFLECTOR

My 12-inch reflector is constructed with aluminum angle stock and rings, to provide great rigidity of the tube, as shown in the photograph. Its focal length is 78 inches. The mirror is parabolized very accurately, and the instrument performs well under high powers on Saturn and Mars.

C. A. OLSON
6520 S. Oakley Ave.
Chicago 36, Ill.



The Olson 12-inch reflector.

OBSERVER'S PAGE

Universal time is used unless otherwise noted.

Configurations of Three Planets Before Sunrise

During the latter part of November, Mercury, Venus, and Saturn will be seen together in the morning twilight sky. From November 22nd to 29th, all of them may be simultaneously observed within a field eight degrees in diameter, typical of the view through prism binoculars.

The accompanying diagram shows how the relative positions of Mercury and Venus will change with respect to Saturn, which is represented by the black disk near the center. Over a 22-day period, four conjunctions among these three planets will take place, each sufficiently far from the sun to be seen with the unaided eye:

Nov. 24	1h UT	Mercury 0° 25′ south of Saturn
Nov. 25	5h UT	Mercury 2° 58′ north of Venus
Nov. 29	0h UT	Venus 2° 32′ south of Saturn
Dec. 16	0h UT	Venus 0° 39′ north of Saturn

During the late months of 1954, Saturn is in conjunction with Mercury and Venus three times each, because its conjunction with the sun (November 5th) occurs close to the times of inferior conjunction of the others. In each case, the second conjunction of an inferior planet with Saturn occurs while the former is in retrograde motion, that is, moving from east to west.

Mercury passed Saturn twice in the evening sky in October, then moved into the morning sky ahead of the ringed planet. As a result, there is only one conjunction of these two as morning stars, and it occurs at a time when Mercury has become a rather brilliant object (magnitude −0.5) nine days after reaching greatest elongation west. Saturn will then be of magnitude +0.8.

On the other hand, Venus does not become a morning star until November 15th, 10 days later than Saturn does. This results in one conjunction in the evening sky (September 16th) and two in the morning, as listed above.

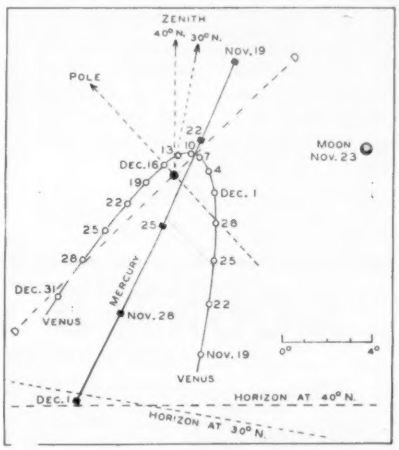
Mercury and Venus pass each other only once during this season, early on November 25th. Their positions at the time of the conjunction are indicated by the line of dots joining their paths in the diagram. Incidentally, it is extremely rare for these two planets to pass each other three times when Venus is near inferior conjunction.

During the first three weeks of December, Venus and Saturn will rise within six minutes of each other, and their angular separation will not exceed two degrees. However, as Venus first retrogrades and then resumes direct motion, it swings around Saturn. In the course of the entire six weeks for which the Venus curve has been plotted, the position angle of the line joining the two planets changes by more than 300 degrees.

On November 23rd, the waning crescent moon will round out this planetary spectacle, and its position has been shown for that date.

In the diagram, the planetary positions have been plotted at three-day intervals for 12h Universal time. This is at 6 a. m. on the 90th meridian. The longitude for which this chart is strictly correct advances progressively westward as the sun appears to move eastward along the ecliptic during the period covered. However, it is sufficiently accurate for all longitudes in the United States, to the same degree as the Graphic Time Table of the Heavens, published in this magazine each January.

To aid in orienting the chart, the eastern horizon of an observer at latitude 40° north is shown when Saturn's altitude is 10 degrees. Correction for other latitudes may be approximated by rotat-



ing the horizon clockwise about Saturn if the observer's station is south of latitude 40°, or counterclockwise if it is north. The position of the horizon and the direction of the zenith for 30° north latitude are also shown.

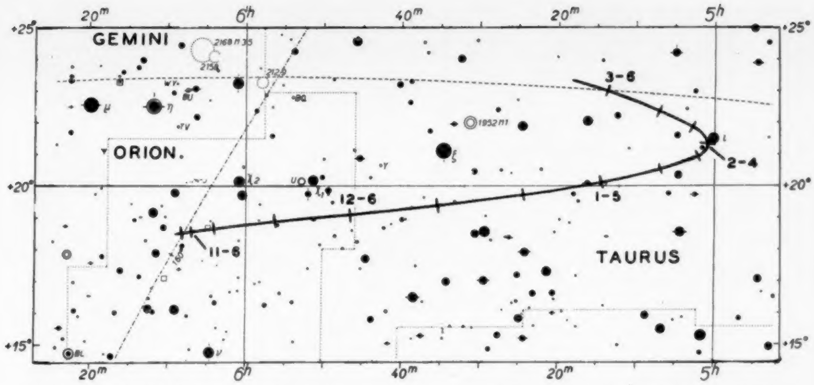
The slanted dashed line toward the celestial pole is the hour circle for Saturn. The conjunctions of Saturn with Mercury and Venus are indicated by the intersections of their paths with this hour circle.

Where a curve crosses Saturn's declination circle D-D, the planet has the same declination as Saturn and rises at the same point on the horizon.

During this period, the 3rd-magnitude star Alpha Librae is near the planets, and it will furnish a good reference point for observing their characteristic motions against the background of the stars. The Graphic Time Table of the Heavens is an aid in making these observations, for it gives the rising times of the objects involved.

PAUL W. STEVENS
Rochester Academy of Science

ED. NOTE: Since Venus is at inferior conjunction with the sun on November 15th, the ephemeris for finding this planet by day with the naked eye is omitted this month.



PATH OF VESTA

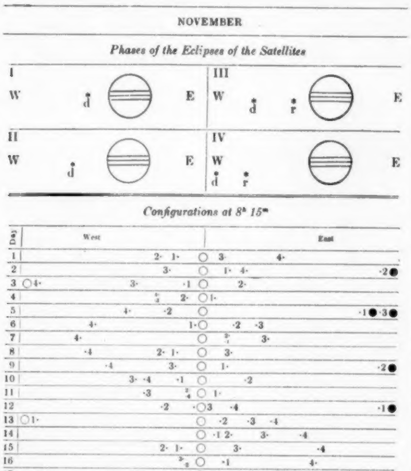
The path of the asteroid Vesta from October 27, 1954, to March 6, 1955, is plotted here on a section of the Skalnate Pleso **Atlas.** The position of the asteroid is indicated for every 10th day. The motion of Vesta will be retrograde until February 4th. Its predicted magnitude is 7.5 in October, and it brightens to 7.1 at opposition to the sun on December 16th. In March it will have faded to 7.8, but until that time Vesta will be brighter than the faintest stars shown on the map.

Right ascensions and declinations of Vesta around opposition time are given at the right. E. O.

JUPITER'S SATELLITES

The configurations of Jupiter's four bright moons are shown below, as seen in an astronomical or inverting telescope, with north at the bottom and east at the right. In the upper part, *d* is the point of disappearance of the satellite in Jupiter's shadow; *r* is the point of reappearance.

In the lower section, the moons have the positions shown for the Universal time given. The motion of each satellite is from the dot to the number designating it. Transits over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the *American Ephemeris and Nautical Almanac.*



PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

Amphitrite, 29, 8.7. Nov. 4, 4:27.3 +30-38; 14, 4:18.3 +30-51; 24, 4:07.5 +30-45. Dec. 4, 3:56.4 +30-24; 14, 3:46.6 +29-52; 24, 3:39.5 +29-14.

Chaldaea, 313, 9.5. Nov. 24, 5:45.0 +3-08. Dec. 4, 5:37.3 +2-05; 14, 5:27.8 +1-28; 24, 5:18.1 +1-20. Jan. 3, 5:09.6 +1-44; 13, 5:03.7 +2-34.

Vesta, 4, 7.1. Nov. 24, 5:57.8 +18-48. Dec. 4, 5:48.7 +19-02; 14, 5:38.0 +19-20; 24, 5:26.8 +19-40. Jan. 3, 5:16.5 +20-00; 13, 5:08.4 +20-23.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1954.0) for 0h Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

LIGHT GRASP OF REFLECTING TELESCOPES

HOW reflectors compare in performance with refractors is an important question for the amateur observer. As far as definition is concerned, refractors professionally made are often superior to homemade reflectors. But when we consider light-gathering power, it seems that the average amateur worries too much about the effect of tarnish of his mirror coating.

As an example, I use my 8.7-inch reflector. The total area of the mirror is 59.45 square inches, but the prism holder and its struts cover 4.82 square inches, leaving a net area of 54.63.

Suppose that the reflectivity of the mirror coating is 85 per cent, the value for freshly deposited aluminum. The effective area is 46.4 square inches, or the equivalent of an ideal 7.69-inch object glass. The limiting magnitude is then 13.63, from the formula: $5 \log \mathbf{A} + 9.2$, where **A** is the effective aperture in inches.

Making the same calculations for various values of the reflectivity gives the results in the table, all for my mirror 8.7 inches in diameter.

A freshly deposited coat of silver may have a reflectivity of 0.95. This would have to tarnish to 0.37 before one magnitude would be lost; tarnishing to 0.55 will forfeit only 0.5 magnitude. Thus the coat would have to become very bad indeed to degrade this telescope to the level of a 5-inch object glass.

Reflectivity	Effective area (sq. in.)	Equivalent refractor (inches)	Limiting magnitude
0.95	51.9	8.13	13.75
0.90	49.2	7.91	13.69
0.85	46.4	7.69	13.63
0.80	43.7	7.46	13.56
0.70	38.2	6.97	13.42
0.60	32.8	6.46	13.25
0.50	27.3	5.90	13.06
0.35	19.1	4.93	12.66

It can also be seen from the table that aluminum loses very little more light than new silver — only 0.12 magnitude.

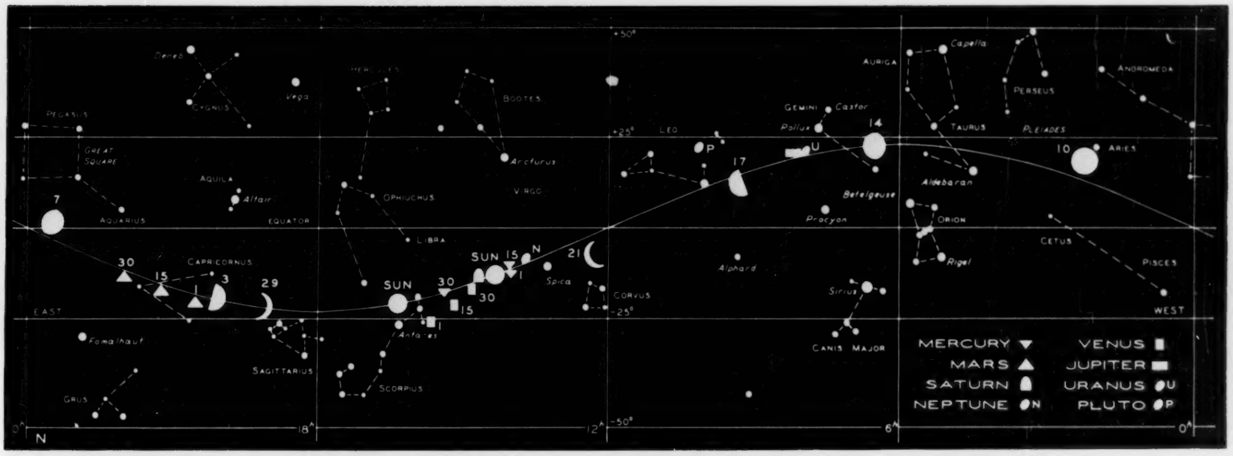
Clearly one need not be too seriously concerned about changes in the reflectivity of a mirror.

O. M. ERPENSTEIN
1395 Hillcrest Blvd.
Millbrae, Calif.

SUNSPOT NUMBERS

August 1, 5, 8; **2,** 12, 9; **3,** 13, 16; **4,** 12, 9; **5,** 15, 12; **6,** 20, 19; **7,** 16, 14; **8,** 4, 10; **9,** 15, 13; **10,** 17, 23; **11,** 17, 14; **12,** 13, 14; **13,** 8, 8; **14,** 1, 0; **15-19,** 0, 0; **20,** 1, 0; **21,** 16, 9; **22,** 19, 15; **23,** 19, 18; **24,** 15, 16; **25,** 10, 11; **26,** 1, 7; **27,** 2, 7; **28-31,** 0, 0. Means for August: 8.1 American; 8.1 Zurich.

Above are given the date, the American number, then the Zurich number. These are observed mean relative sunspot numbers, the American computed by D. W. Rosebrugh from AAVSO Solar Division observations, the Zurich numbers from Zurich Observatory and its stations in Locarno and Arosa.



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury in mid-month will be favorably placed in the morning sky. At greatest elongation, on the 15th, it will be of magnitude −0.3, located 19° 29′ west of the sun and rising 1½ hours before it. The planet may be easily observed until early December.

An unusual grouping of three planets will be visible on several mornings around November 24th, when Mercury and Saturn will be in conjunction at 1^h UT, the latter being 25′ north. Venus will be 4° to the southeast, and the crescent moon 6° south of the first two. See the article on page 33.

Venus, in early November, is an evening object, but poorly placed for observers in northern latitudes. On the 1st, it is of magnitude −3.9 and sets half an hour after the sun. Inferior conjunction takes place on the 15th, with Venus passing 3° 43′ south of the sun at 7^h UT. By the 24th of the month, Venus will rise one hour before the sun, appearing telescopically as a thin crescent 61″ in apparent diameter, with only three per cent of the area of its disk illuminated.

Mars continues its rapid eastward motion across Capricornus this month. The red planet, at magnitude +0.3, sets an hour before midnight in mid-November.

Jupiter, in western Cancer, rises 3½ hours after sunset at the end of November. Retrograde motion begins on the 17th, when the planet shines at magnitude −2.0, and presents an apparent equatorial diameter of 43″.

Saturn, in conjunction with the sun on the 5th, will again be visible in the morning sky by the last week of the month. It is in conjunction with Mercury on the 24th, and appears 2° 32′ north of Venus on the 29th.

Uranus is located about 2° west of Jupiter, and rises just before it. Slow retrograde motion begins on November 3rd. This 6th-magnitude planet is easily found with slight optical aid, by means of the chart of its path on page 137 of the February issue.

Neptune is near the sun in the morning sky. E. O.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown.

MINIMA OF ALGOL

November 3, 2:37; 5, 23:26; 8, 20:15, 11, 17:04; 14, 13:53; 17, 10:42; 20, 7:31; 23, 4:20; 26, 1:09; 28, 21:58. December 1, 18:47; 4, 15:35; 7, 12:24.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Cracow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

OCCULTATION PREDICTIONS

Data for the immersion of 1 Geminorum at stations **B** and **D** on November 12-13 was published in the October issue.

VARIABLE STAR MAXIMA

November 5, S Hydrae, 084803, 7.9; 5, R Aquarii, 2338**15**, 7.3; 9, R Leonis Minoris, 093934, 7.2; 10, R Cassiopeiae, 235350, 6.5; 14, R Octantis, 0556**86**, 7.9; 14, S Pavonis, 1946**59**, 7.3; 14, R Indi, 2228**67**, 8.0; 22, X Centauri, 1144**41**, 7.8; 22, RS Herculis, 171723, 8.0; 23, R Virginis, 123307, 6.9; 23, R Aquilae, 190108, 6.3; 28, T Herculis, 180531, 8.0; 30, RR Scorpii, 1650**30**a, 6.0. December 4, T Aquarii, 2044**05**, 7.9; 5, R Trianguli, 023133, 6.3; 7, U Ceti, 0228**13**, 7.5; 9, S Carinae, 1006**61**, 5.7.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

OPTICAL BARGAINS

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Buy our mirror mount to fit the above:

Stock No. 50,011-Y
$5.25 Postpaid

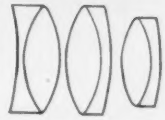
15X SPOTTING SCOPE

A miniature scope with amazing big-scope qualities! Only 7" long, fits handily in the side pocket of your jacket. Collapsible tripod with ball-joint mount for viewing in any direction and "fixing" on target. Coated objective lens, Ramsden eyepiece, achromatic objective. Threaded focus adjustment. Rubber feet on tripod. Total height, 10".

Stock No. 70,035-Y **$19.95 Postpaid**

Look At This Amazing Buy!

MOUNTED ERFLE EYEPIECE



68° Field

Consists of 3 coated achromats in metal mount with spiral focusing. F.L. 1¼". Dia. 54 mm., length 54 mm. War surplus. Govt. cost about $84.00. This is the type war surplus bargain that will be talked about in years to come. Buy while you can. Our price will jump soon.

Stock No. 5160-Y $8.50 pp

War Surplus ELBOW TELESCOPE

M-7

8 Power

U. S. Govt. cost about $300.00!

Use this quality telescope as a finder or use it as a low-power spotting telescope wherever its right-angle viewing is desirable. Cemented achromatic doublet objective, F.L. 8⅝", speed f/4.5, clear aperture about 45 mm. F.L. of eyepiece 27 mm. Amici roof prism erector. Eye relief 25 mm. All air-glass surfaces coated in coated model (see below). Field of view 6°. C and F lines color corrected. Spiral focusing, minimum focusing distance 79 feet. (Note: if reticle is not required, minimum distance becomes 19 feet.)

Included: Clear, yellow, red and neutral density filters. Cross-hair reticle, with provision for lighting. Sunshade. Mounting platform.

Length 12", width 5", height 6". Weight 3¾ lbs.

ALL AIR SURFACE LENSES COATED
Stock No. 70,046-Y .... **$32.50 Postpaid**
NOT COATED
Stock No. 70,044-Y .... **$27.50 Postpaid**

60° SPECTROMETER PRISM

Polished surfaces flat to ½ wave length. Angle tolerances 5 minutes. Dimensions of polished surfaces 18 mm. x 30 mm. Made from dense flint glass, free of striae and strain.

Stock No. 30,143-Y $8.25 pp

TELESCOPE EYEPIECE

Consists of two achromatic lenses F.L. 28 mm. in a metal mount.

Stock No. 5140-Y .. $4.50 pp

Same as above but about 1¼" extension has been added with O.D. of 1¼", which is standard.

Stock No. 5223-Y .. $5.25 pp

50x MICROSCOPE & 10x TELESCOPE

New 2 in 1 combination! Pocket size! No larger than a fountain pen. Sharp focus at any range. Handy for sports, looking at rare objects or just plain snooping.

Stock No. 30,059-Y. $4.50 pp

10X - 15X PRISM ERECTING Wide Field TELESCOPE War Surplus!

Artillery Observation Instrument. Original Cost to Govt. $1200. The clear bright image and extra-wide field make it adaptable to any use. Easy-to-operate azimuth-finding system built in. It has heavy-duty tripod and heavy leather carrying case.

Specifications

Clear dia. of objective 3". E.F.L. approx. 28". Prismatic erecting system. 2 eyepieces with amber filters provide 10x and 15x. 5-mm. to 7.5-mm. brilliant field exit pupil. Crossline reticle — pointer moves across horizontal reticle scale. 360° traverse, 45° vertical travel, each controlled by knobs. Azimuth scale on table in degrees, scale on knob in hundredths of 1°. Lighted scales and eyepiece reticle (battery not included). Adjustable bubble levels for table. Max. height approx. 61½". Length of scope 26". Weight of scope and tripod 74 lbs. Shipping weight 150 lbs. Heavy-duty tripod included. Price includes all accessories.

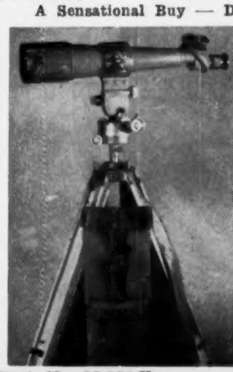
Stock No. 80,030-Y .... **$78.50 f.o.b. Barrington, N. J.**

Brand New — with additional accessories

Stock No. 80,026-Y .... **$149.50 f.o.b. Barrington, N. J.**

U. S. ARMY SURPLUS TRIPLE TURRET TELESCOPE

A Sensational Buy — Dozens of Uses



Eyepieces for 15, 23 and 30 power mounted on a rotating turret. Parfocal. 3" dia. achromatic objective. MOUNT: Rotates 360° in azimuth. Bubble level on elevation control. Instrument has prism-erecting system — brass construction. Length 20". Max. height 72". Used but in good condition. Comes with leather carrying case for telescope and mount; fiber case for tripod.

Stock No. 85,003-Y .... **$89.50 f.o.b.**
(Shipping Wt. 70 lbs.) **Barrington, N. J.**

ORDER BY STOCK NUMBER . . . SEND CHECK OR MONEY ORDER . . . SATISFACTION GUARANTEED!

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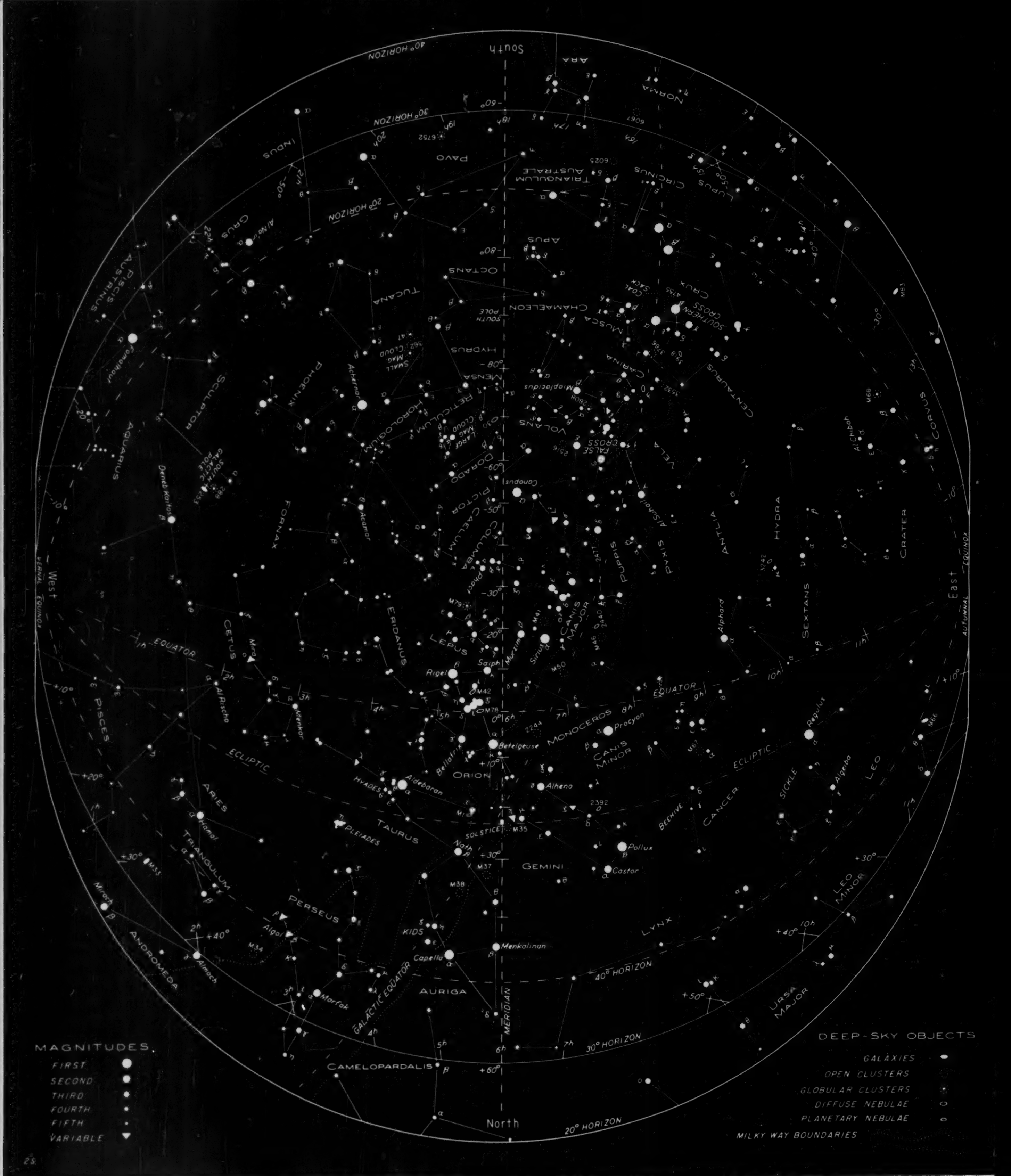
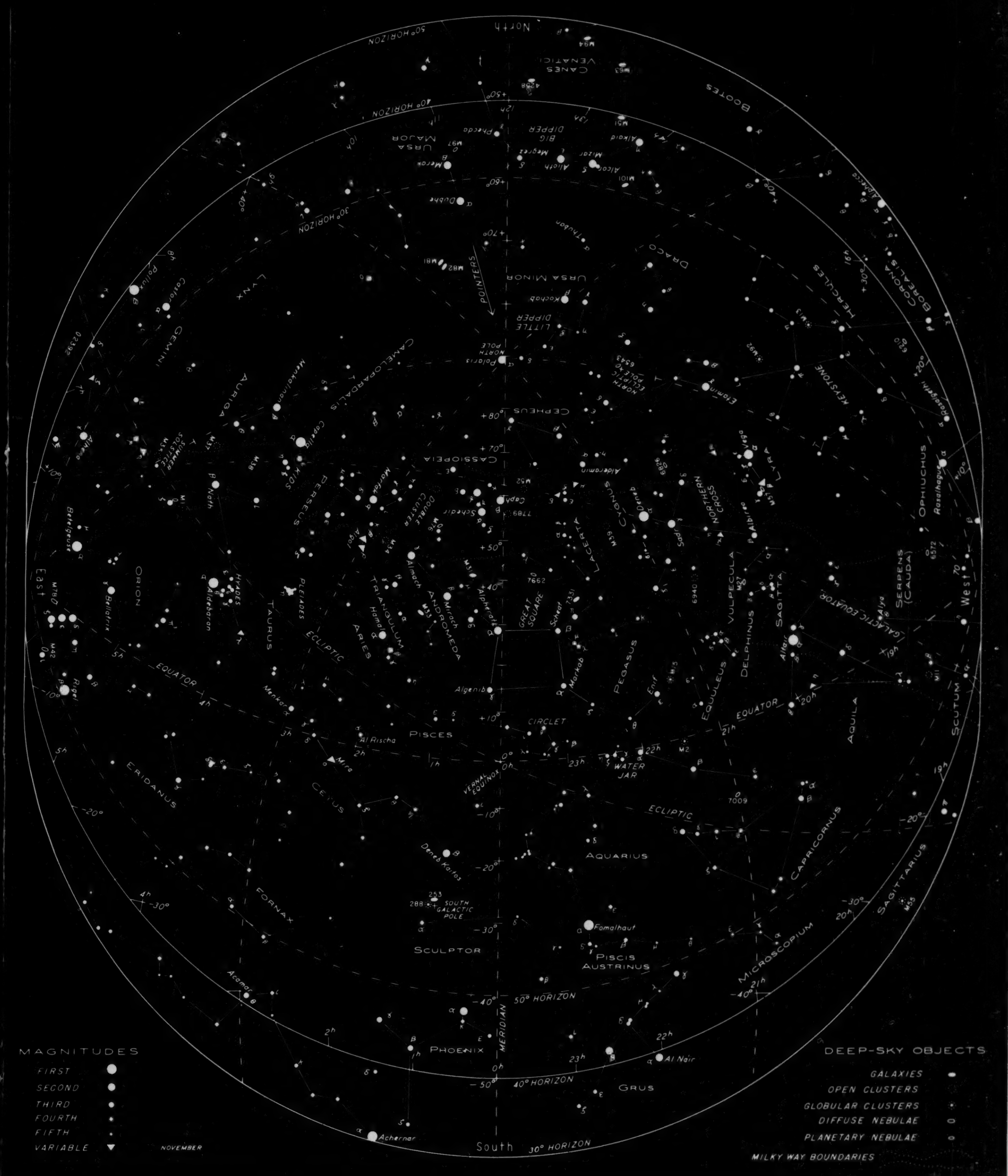


SOUTHERN STARS

The sky as seen from latitudes 20° to 40° south, at 11 p.m. and 10 p.m., local time, on the 7th and 23rd of January, respectively; also, at 9 p.m. and 8 p.m. on February 7th and 23rd. For other times, add or subtract ½ hour per week.

At the time of this chart, the observer in latitude 30° south has 15 stars of magnitude 1.5 and brighter above his horizon, and this year two bright planets as well, Mars in the constellation of Pisces, the Fishes; Jupiter in Gemini, the Twins. Sirius and Canopus are high in the sky.



STARS FOR NOVEMBER

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of November, respectively; also, at 7 p.m. and 6 p.m. on December 7th and 23rd. For other times, add or subtract ½ hour per week.

In this chart, the circle of right ascension that passes through the March or vernal equinox point in the sky is on the meridian. Therefore, the sidereal time at the moment of this chart is 0^h. It will be 1^h when the point marked 1^h on the equator reaches the meridian, and so on.

DEEP-SKY WONDERS

THE MESSIER objects, of which a complete list was given in the March issue, are always popular, no matter what the equipment available. They form the bulk of the nebular objects listed in Garrett P. Serviss' *Astronomy with an Opera Glass*, a book from which thousands of my generation learned their stars, and which is still a stimulating guide. Let us turn to a few Messier objects that we have not mentioned for many years.

In Pisces at $1^h\ 34^m.0$, $+15°\ 32'$ (1950), is M74 (NGC 628), a great spiral galaxy 8′ in diameter. The delicate, sharply defined arms are very regular, which, together with the broadside presentation, makes this a perfect object of its type. The arms cannot be seen in small telescopes, although the galaxy itself was noted with a 3-inch, 10x refractor at Bonn during the observations for the BD star catalogue. The magnitude has been cited as 9.6 visual and about 11.2 photographic. Admiral Smyth curiously did not include it in his Bedford catalogue, and Sir John Herschel in 1864 listed it as a globular cluster! The 200-inch photograph of this object, reproduced on the back cover of the March, 1950, *Sky and Telescope*, is one of the most beautiful astronomical photographs ever taken.

M76 in Perseus, at $1^h\ 39^m.1$, $+51°\ 19'$, is a most irregular planetary which the small telescope shows as two patches (NGC 650 and 651) in contact. To James Corn, on October 27, 1951, it appeared much like a dumbbell. Bigourdan, with a 13-inch refractor, called it rather bright and 1′.8 by 1′ in size; and his statement that it is well visible in bright moonlight suggests that the photographic magnitude of 12.2 assigned to this nebula is too faint.

The Sb galaxy M77 (NGC 1068) is at $2^h\ 40^m.1$, $-0°\ 14'$, in Cetus. About magnitude 9 visually, it is 2′ by 2′ in size. Early observers reported this as a mixture of stars and nebulosity but, as in several other cases, the giant telescope of Lord Rosse decided its spiral character. In amateur instruments it is a small, fuzzy, formless object.

A concentrated cluster of a few large and many small stars, M34 (NGC 1039) in Perseus is 30′ in diameter. Situated at $2^h\ 38^m.8$, $+42°\ 34'$, it is just visible to the naked eye. Earlier writers mentioned M34 merely for its double stars, but the Rev. T. W. Webb justly called attention to it as a grand low-power rich-field object. And indeed, while not as rich as the nearby Double Cluster in Perseus, M34 is one of the finest sights in wide-field telescopes that can be found.

WALTER SCOTT HOUSTON

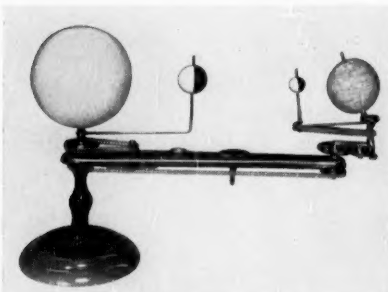
MOON PHASES AND DISTANCE

First quarter	November	3, 20:55
Full moon	November	10, 14:29
Last quarter	November	17, 9:32
New moon	November	25, 12:30
First quarter	December	3, 9:56

November			Distance	Diameter
Perigee	10,	13^h	221,500 mi.	33′ 31″
Apogee	24,	0^h	252,600 mi.	29′ 24″
December				
Perigee	9,	2^h	222,700 mi.	33′ 20″

ASTRONOMY STUDY AIDS

No. 701 Spitz Junior Planetarium. A new visual teaching aid brings a knowledge of the heavens into your classroom or home. A plastic globe is perforated with small apertures and contains a pinpoint light source inside. Stars and constellations are projected on the ceiling; a dome is helpful, but not necessary. Adjustable for date and latitude. Size: 14½" high, 7½" square base. Weight 3 lbs. Operates on 110-volts. Complete with 32-page star guide. **Postpaid $15.00**



No. 708 Trippensee Planetarium. This demonstration device shows the relative position and motion of the Sun, Earth, Moon, and planet Venus. Simplifies teaching the rotation of the earth, the annual revolution around the Sun, day and night, change of seasons, and the mechanics of eclipses. This is an orrery-type device and not a projection planetarium. Constructed of brass with chain drive gears. Arm length is 16½", overall height 16". Hand operated. **$75.00**

No. 731 Celestial Globe. This full 9" diameter globe has an attractive base and setting that makes it ideal for display in the school-room or home. A dark blue background makes the yellow stars stand out for easy recognition. Stars to the sixth magnitude included. Ecliptic and equator emphasized. Constellation outlines and mythological figures in light blue. Movable meridian for latitude. Brown plastic cradle supplies horizon as well as effective base. With handbook. **$14.50**

No. 791 World Wide Planisphere. This unique guide to the constellations and navigation stars enables one to find what stars are overhead at any point on earth, at any time of day or night. Developed by Wm. H. Barton, Jr. Plastic-ring bound, 10" x 10½". **Postpaid $3.00**

No. 740 Deluxe Celestial Globe. Our finest 16" globe was designed as a visual aid by teaching astronomers. All stars of the first six magnitudes are shown on a pale blue background, with the first three magnitudes having bright yellow circular backgrounds. Brighter stars named and constellation boundaries indicated. Declination and right ascension circles printed in black. Magellanic Clouds and Milky Way stand out in white, with important star clusters indicated. Various models available.

No. 740-1	**Plain low table base (Illus.)**	**$49.50**
740-3	**Weighted table base, movable meridian**	**57.50**
740-5	**Weighted table base, movable meridian with horizon**	**67.50**
740-5d	**Weighted floor base, movable meridian with horizon**	**75.75**

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